AMATEUR WORK

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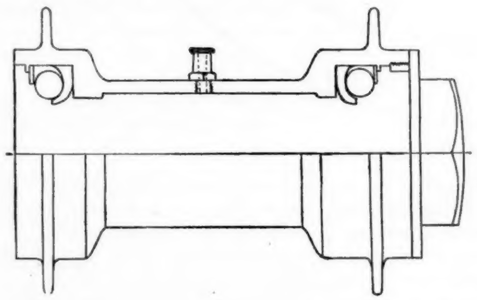
THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

II. The Wheels.

In building the wheels, as well as the rest of the car, the reader is advised to visit any auto' supply agencies and repair shops which may be conveniently reached, as, by so doing, he may be able to secure needed parts at bargain prices. The present tendency of the regular trade is towards large cars, and unused parts required for the smaller cars can frequently be found if searched for, and at very attractive prices. This is especially true of the wheels, a set of four hubs, $6\frac{1}{2}$ x 4 in. full nickled and the two front ones fitted with the balls, were obtained by the writer for $6.00.



As quite a supply of these hubs are available to builders of this car, no extended description will be given. The diameter of the cups, fitted to front knuckles, is $1\frac{3}{4}$ in. from center to center of the balls, and the cups are spaced $4\frac{1}{4}$ in. apart. These dimensions will enable any one to secure knuckles of the correct size. The balls, 15 in number, are $\frac{3}{8}$ in. diameter.

The question of rim is not so easily determined, as the kind of tire to be used must first be selected and the rim be one upon which the tire can be used. The prevailing practice is now almost exclusively a double tube tire, of which there are several excellent makes available. The single tube tire has the great disadvantage of being very difficult to repair in case of a puncture, but the first cost is less than for the double tube. The total cost for several seasons' use will, however, undoubtedly be in favor of the double tube tire, and the greater ease of repair of the latter, especially when far away from a repair shop, as one is quite likely to be when trouble happens, makes the difference in first cost a matter of minor importance. It is also well to call attention to the fact that several new and recent improvements in the manner of attaching the tire to the rim, require that the builder familiarize himself with the leading styles, which can be quickly done by visiting several storage and sales rooms and examining the new cars, those of last year, and previous, not having the latest and best devices. The solid tire, owing to the high cost of crude rubber, costs so much that it has been given no consideration.

The kind of tire being selected, tne rims for same should be secured. They should have 40 holes for the spokes, the hub having the same number, 20 on each end. The holes in the hub are all countersunk for the heads of the spokes, one-half have the heads on the inside of the flange, and the other half on the outside. The wiring of a wheel may, at first glance, seem complicated, but a little study of the illustration will show how the spokes are arranged.

The hub should first be suspended so that it may revolve freely and yet be held in place. A frame can be made from boards for this, or a round piece of wood or the axle can be secured in a vise, upon which the hub can be suspended. It is necessary to have the hub revolve, so that when the spokes are finally tightened the rim can be trued up, and this can only be ascertained by turning it on the axle.

The illustration shows the spokes of only one end of the hub, the arrangement for the other end being exactly the same, with the exception that the outer ends are one hole to the right or left, as may be found best for the particular rims and spokes used. The spokes for a 28 in. wheel are 12 in. long of 6-8 gauge, both ends being of greater diameter than the main part of the spoke. At the outer ends, nipples, with washers un-

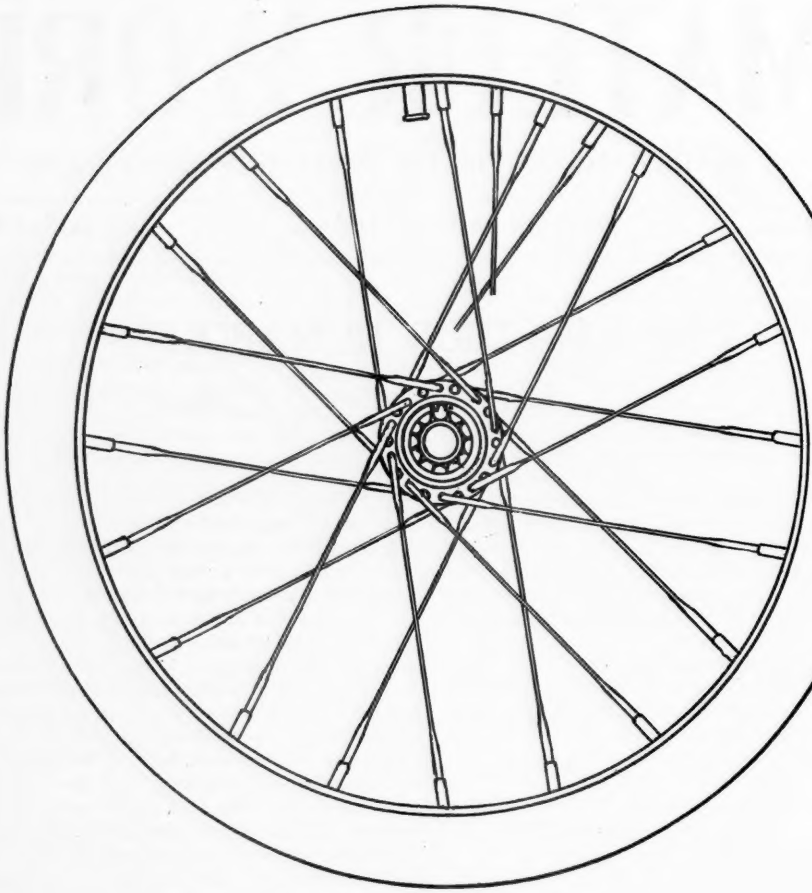


FIGURE 4. WIRING DIAGRAM.

der the heads, unless the rim is thick enough so that they are not needed, keep the spokes at the proper tension, being threaded; the nipples having a slot in the head for turning up with a screw driver, and also flats on the sides to take a wrench so that the spokes may be tightened when necessary after the tire is on.

To set up a wheel proceed as follows:—Put in the spoke shown at the top of the illustration to the right of the inflation valve. It will be seen that the head of this spoke is on the inside of the flange and placed in the fourth hole to the right of the one at the top center. Three holes to the left of the top center hole place a spoke with the head on the outside and the outer end in the hole in the rim the second to the right of the first spoke. The rim hole between these two contains the spoke from the other end of the hub corresponding to the first spoke, and shown in part in the illustration. Two holes to the right is the spoke from the same end of the hub and corresponding to the second spoke mentioned. Continuing again with the spokes on the end first mentioned, put a spoke through the second hole below the one containing the first spoke, carrying the outer end to the fourth hole in the rim to the right of the first spoke. The arrangement of the rest of the spokes is so clearly shown in the illustration that no difficulty should be experienced in setting them.

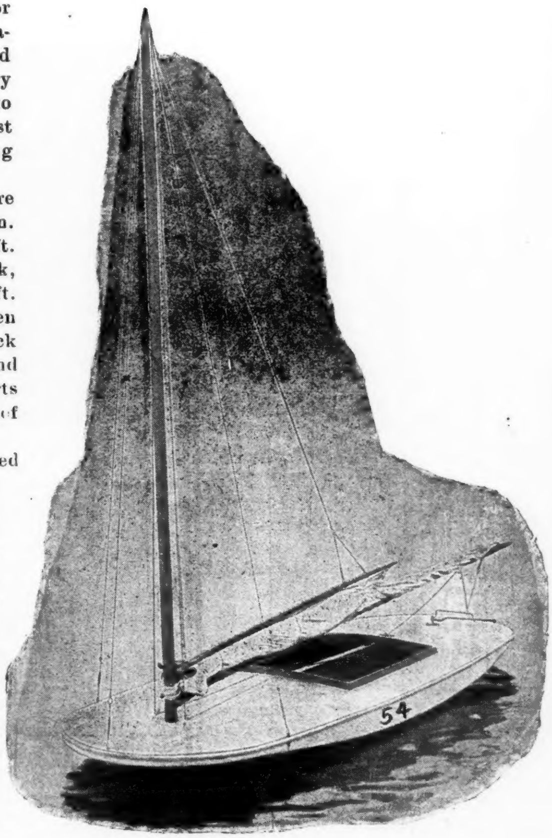
The nipples are given only a few turns at first, the final adjustment and truing up being done when all the spokes are in place. As already stated, washers should be placed under the heads of the rims for double tube tires, rims of thin steel are used, and rims for double tub tires are of this description, and washers should therefore be used on them. When the final truing up is done, revolve the wheel frequently, holding the end of a stick or other indicator on a steady rest, so that any uneven places will be noticed and worked out by adjusting the tension of spokes.

The complete car will weigh about 600 pounds, varying from this if lighter or heavier parts are used.

A RACING SAILBOAT.

C. C. BROOKS.

Full size patterns for this boat may be obtained of the Brooks Bout Mfg. Ba., Grand Rapids, Mich.



The boat here described is a very popular design for inland ponds and lakes and sheltered bays on the sea-coast. It is very stiff in a squall, easily handled, and such a boat can be constructed by anyone of ordinary skill with woodworking tools. To those unused to sailing boats and wishing to make a start in this most pleasant sport, this design is recommended as being one of the best and safest which can be made.

Those parts requiring white oak, rock elm or fir are as follows: One piece 16 ft. long, 3 in. wide, 1⅛ in. thick, for the two bent end pieces. One piece 6 ft. long, 12 in. wide, 1⅛ thick, for the skeg, butt block, head ledge, stern post and spar step. One piece 12 ft. long, 6 in. wide, ⅞ in. thick, for center-board. Fifteen pieces 12 ft. long, ⅞ in. square, for ribs and deck beams, twenty-eight running feet of ⅞ in. half-round for fender wale. (NOTE.—Fir may be used for all parts excepting the two bent pieces that form the ends of of the boat.)

Of pine, cypress, cedar, fir or spruce, there is needed two pieces 14 ft. long, 17 in. wide, and one piece 12 ft. long and 15 in. wide, all ⅞ in. thick, for back-bone. (NOTE.—If you can get two pieces 18 ft. long and 17 in. wide, you can make the back-bone without splicing it. There will be enough waste lumber left from the backbone to make the cheek pieces. Two pieces 14 ft. long, 8 in. wide and ⅞ in. thick for sides. Two hundred and twenty-five surface feet ⅝ in. thick for planking, decking and coaming. Get this in 12, 14 or 16 ft. lengths and 12 in. or more wide. To make this ⅝ stock you can have 180 ft. (board measure) of 1½ in. lumber resawed and dressed. One piece 16 ft. long, 3 in. square, for spar. One piece 18 ft. long, 2½ in. squarefor boom. One piece 10 ft. long, 2 in. square, for gaff. (NOTE—Spruce makes the best timber for the spars.)

For hardware, obtain four pounds 1⅝ in. clout nails for planking and decking. Two pounds 2 in. common wire nails for fastening plank to back-bone, ends and sides. One pound 8-penny casing nails for fastening ribs and deck-beams. Eight 4-in. wire spikes for fastening skeg. One package of two ounce tacks. Two and one-half dozen 1¼ in. No. 12 screws for cheek-pieces, back-bone and end pieces. Two dozen 1¼ in. No. 12 screws for fastening butt blocks to end pieces. Two dozen ¼ in. carriage bolts, 3 in. long, for back-bone. One ½-in. carriage bolt, 4⅝ in. long, for king-bolt for center-board. One pound spun calking cotton. Sand-paper, putty and paint.

To make the sail and rigging, get 33 yards of 6 or 7-ounce duck, 30 in. wide, for sail. If roped in hem, 61 ft. of cotton rope. If roped outside, 40 ft. of ½ in. Russian bolt rope. (See instructions for making sail.) Forty feet of ¼ in. wire rope rigging for stays. Three ¼ in. pipe turnbuckles, 8 in. long, with eye and shackle for stays. Six 4-in. mast hoops. One sheet traveler of ⅝-in. rod, 18 in. long. Five single ⅝-in. blocks, without beckets. Three single ⅝-in. blocks with beckets. Three 4-in. deck cleats. Two ½-in. eye bolts, 3 in long. Two ¼-in. eye bolts, 3 in. long. Two wire staples, 2½ in. long. One hundred and sixty-five feet of ⅜-in. manila rope for halyards and sheet. Thirty-five feet of ¼-in. cotton rope for lacing on sail. Twenty feet of marlin.

For the frame we recommend white oak, this being the best timber known for this purpose. If, however, suitable oak is not easily procurable, we would advise fir or rock elm as a very satisfactory frame timber. When purchasing the lumber it is not necessary to

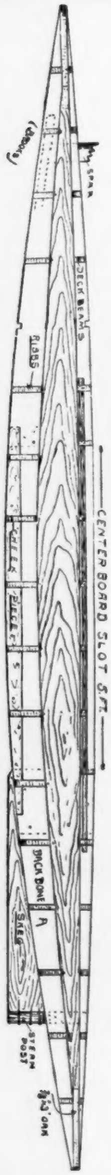


FIGURE 2. BACKBONE.

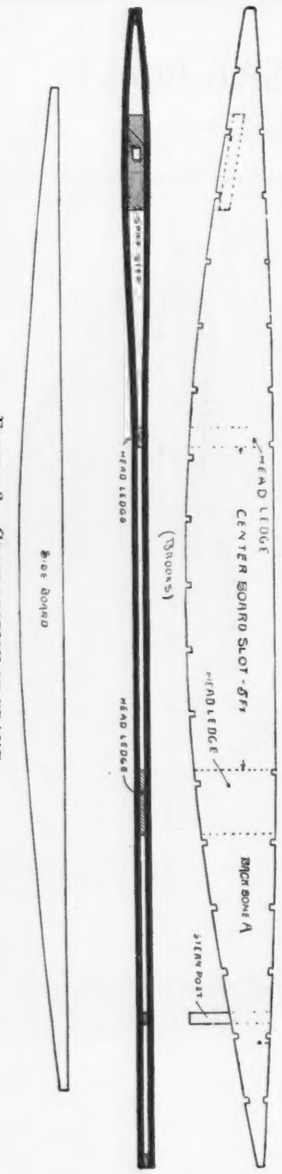


FIGURE 3. CROSS SECTION OF FRAME.

adhere to the dimensions given, but good judgment should be used in not making any of the parts too light.

The lumber in bill of material should be well seasoned. The oak for the end pieces should be straight grained and not kiln dried, as this injures its bending qualities. The lumber for planking should be of good, sound quality. A few sound, small knots may be used, and thereby make a material saving in the cost of the lumber. In the bill we have given the dimensions to which you should have the lumber dressed. The bill of material gives the thickness of the lumber for each piece, the patterns give the shape. The bill also gives the size of the nails, screws or bolts used for the different fastenings. In building the boat, take up each step in the same order as given in the instructions.

We assume that you are an amateur, and therefore give details that will appear unnecessaty to practical mechanics. One important point to the amateur is, keep your tools sharp and in good condition. One of the great faults of the novice is that he will attempt to use dull tools, resulting in rough work, which he attributes to his inexperience, while, in fact, a skilled mechanic could do no better under the same conditions. The amateur should not expect to understand every detail from simply reading the instructions. The points that now appear hazy will be plain when you are working on the actual construction.

A light, warm shop makes boat building pleasant. On one side have a work bench with plank top about 2 ft. 8 in. high and not less than 16 ft. long. Have a carpenter's vise at the left hand end. You will need a claw hammer, clinch iron, rip saw, cutting-off saw, smooth plane, block plane, screw driver, draw shave, ratchet bitstock, ½ in. bit for carriage bolts, a No. 6 German bit for the No 12 screws, a No. 2 German bit for the nails of planking, a brad awl for the decks, etc., a counter-sink and screw driver for bitstock, four iron clamp screws of five inch openings, a two-foot rule, plumb bob and line, and a one-half inch chisel.

Before driving a nail or screw, always first bore with a bit slightly smaller than the nail or screw, and countersink for the head of the screw. For No. 12 screws use No. 6 German bit. Before putting in a bolt always first bore with a bit same size as bolt. All bolts are driven from the outside in; that is their heads are always on outside of boat. A washer is always put under all bolt nuts. A clinch iron (flat iron will do) is always held opposite or against all nails when they are driven or set.

The following instructions are given for those using prepared paper patterns:

When the patterns do not intersect you may cut them apart for convenience. Lay the pattern on the material, place it so it will cut to the greatest advantage and not waste lumber, fasten patterns securely with a few tacks, and then prick through with an awl on lines of patterns. When the lines curve, make the prick marks close; follow outside of the line which gives you room to dress with plane after the piece is cut out; take pattern off and drive some nails in the marks made by awl. Now take a thin strip or batten and bend it up to the nails, then mark in the line. This will reproduce the same lines on the lumber that are on the pattern. This method saves the pattern from being destroyed. Another way is to use a tracing wheel, the same as used in dressmaking, and by rolling it over the pattern the points will prick through and leave a mark so that the battens will be unneces-

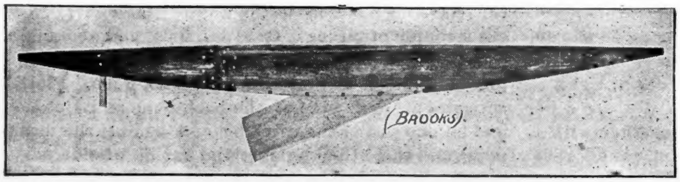
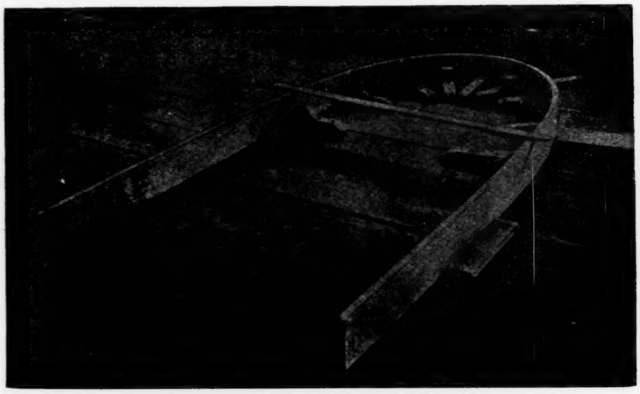


FIG. 4.



G. 5.

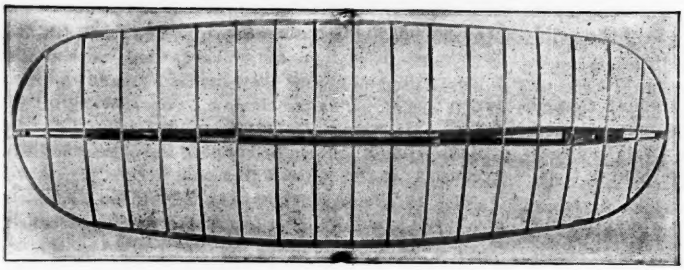


FIG. 6.

sary. A handy way to mark out the plank is to cut the patterns apart, lay them on the material and drive some small nails through the patterns on the lines, then bend battens up to nails, and by using the sharp point of a knife the patterns will be cut to shape and the material marked at the same time.

Make two ordinary saw horses, such as carpenters use. Make these about 20 in. high and 6 ft. 6 in. long.

THE BACKBONE.

The first step is the making of the backbone. This forms the truss that gives strength to the boat and takes the place of keel and center-board box in ordinary sail boats. The backbone extends the length of the boat, and reaches from top to bottom edge, holding the ribs and its top edge, the deck-beams.

The backbone is made double for the full length and consists of two boards bolted together with the mast-step, head-ledge, butt-block, stern-post and after butt block fastened between them. With the pattern of the backbone is given a pattern showing an edge view of the backbone with these pieces in place between the two boards that form the sides of the backbone.

This is also plainly shown in illustration 2.

First get out the two sides of the backbone and shape both of these from the one pattern (marked backbone.)

NOTE.—If you have been able to get these boards in 18-ft. lengths, each side will be made in one piece; however, this is seldom possible. The usual way is to make each side of the two pieces, letting them end on the butt-block that forms the after head-ledge of the center-board box. For this reason an extra wide piece is used for this butt-block, which allows of two rows of bolts, as shown in illustration 4. This makes it just as strong as though the sides were in one piece.

Now, get out the head-ledge, butt-block and stern-post, and place these pieces at their stations between the sides, as shown on the patterns, and clamp the whole together, fastening with ¼-in. carriage bolts 3 in. long. For these three pieces use about 22 bolts, as shown in illustration 4.

Shape the mast-step from the pattern (marked step.) The mast-step should be about 2¼ in. thick, and as your material for this is 1½ in. thick, get out two pieces and nail them together to give proper thickness. You need mortise the hole that receives the end of the spar in the top piece only. Put the step in place and then bring the two ends of the side together at the forward end, holding with clamps, and fasten with a dozen nails through sides into edge of step, and with two or three 1½-in. No. 12 screws at the end of sides to hold them in place.

The after end of the backbone is not brought together, as is the forward end, but has a block 1½ in. thick between the side pieces, as shown on patterns. This is also shown in illustration 2. This end block is fastened in place with a couple of ¼ x3 in. carriage bolts.

Get out the two cheek pieces and cut the mortises to receive the ribs in their lower edge, as shown on patterns. Fasten the cheek pieces on each side of the backbone with twelve 1½-in. screws to each cheek-piece, then cut the rest of the mortises in the backbone. These are to receive the ribs and deck-beams, which pieces extend clear across from side to side of

boat, excepting at the center-board, and at this place the ribs end in mortises of the cheek-pieces, as shown in illustration No. 6. Cut the mortises a scant ⅜ in. square so that the ribs and deck-beams will fit tight.

CENTER-BOARD.

Make this of three pieces doweled together with ½ in. drift bolts. Cut the dowels from ½ in. round rods and have them about 9 in. long. Put the three parts that form the center board together and bore through the edge of the two outside ones into the edge of the middle one, then drive in the drift-bolts. The board may then be trimmed to shape of pattern. Another way to fasten the center-board together would be to let in three iron straps on each side so that they would be flush. These straps should be ⅛-of an inch thick and one inch wide. Have them drilled and countersunk every three inches for ¼-in. rivets, the same rivet fastening the strap on both sides. After riveting on the straps, file down the heads so that they will be flush with the sides of the board to prevent binding. Or, a third and perhaps the simplest way would be to have the center-board cut from a plate of sheet iron ⅛ of an inch thick. (NOTE.—If iron center-board is used reduce the thickness of the head-ledge and buttock to ⅝ of an inch.)

The after end of the board is connected by a clevis to a chain for raising and lowering it, and the forward end is fastened in place by the king-bolt. This is a ½-in. carriage bolt, 4½ in. long that is put through the cheek-pieces, back-bone and center-board, at the point marked with a small circle on the patterns.

TO SET UP BOAT.

Get out the two side boards. These are both shaped from the pattern marked "side". Next, cut out and shape the two end pieces. These are straight pieces about 7½ ft. long and 3 in. wide, and are bent to a circle, shown on patterns.

Illustration 5 shows the manner in which the end pieces are bent. The illustration, however, shows a larger piece than the end piece is. To bend the end pieces, nail up some blocks on the floor to give the same circle as is shown by the pattern; then steam the pieces well and bend them on while hot, after which they may be secured by nailing on a stay, as shown in illustration 5.

Place the two saw horses about 13½ ft. apart and parallel to each other; place the back-bone in the middle of these horses, letting an equal amount extend beyond each horse; place the back-bone on edge with its bottom edge up. Nail four pieces, 1½ in. thick, on top of horses, one piece on each side of the back-bone on each horse. Each one of these pieces should be about two feet long and be placed at the outer ends of the horses.

The object of these pieces is to properly raise the side. Place the two side boards on edge, upside down, so that they will be parallel to the back-bone and about three feet from it. Have the ends of the side pieces extend an equal distance beyond the horses. These side pieces will, of course, rest on the 1½ blocks that have been nailed to the top of the horses. Now cut a couple of pieces 2 ft. 9½ in. long and about 6 in. wide. These pieces are for spreaders, to hold the side pieces in proper distance from the back-bone. Place a spreader at each side of the back-bone at its center, and let one end of the spreader end against the back-bone, and the other against the inside of side piece. These pieces may be held temporarily by toe-nailing them to place.

After the spreaders are in, the ends of the sides are each drawn in until the two sides are five feet apart at the ends, measuring from their outer edges. The sides may be held in place by blocks nailed on the horses,

Try both end pieces up to place and round off the back-bone to fit the curve of the end pieces. When fastened in place, the end pieces connect the ends of the two sides and the back-bone. These end pieces are purposely made a little long so that you may saw them off to exact length after they are in place. First, fasten the center of the end pieces to the ends of the back-bone with a couple of 1½ in. No. 12 screws and two or three casing nails. Have the top edge of the end piece flush with the top edge of the back-bone. Saw off the ends of the end pieces so that they will butt against the ends of the side pieces (that is the two pieces will come end to end). This joint, or butt, is fastened by putting a butt-block, covering the joint on the inside, as shown in illustration 6. This butt-block is of 1½ in. oak about 8 in. long. The end pieces are fastened to the block with three or four 1½ in. No. 12 screws in each piece. Where these butt blocks come on the end pieces, they should be made to fit the curve.

RIBS.

Make a bending form by shaping the edge of a board to conform to the pattern (bending form). This form is used to shape the ribs, and it is given with more bend than is required, for the reason that the ribs will straighten some when they are taken off the form. It will be convenient to make the bending form from two boards with short pieces nailed across them so as to make it wide enough to allow of a number of ribs being bent at the same time. If made in this way the form would resemble the truss which masons use to construct an arch over doors and windows in brick walls.

Either steam or soak the ribs in hot water and bend them on the form, tying their ends down with cord. Let them stand until cold, then remove them one at a time and fasten directly to place. The ribs go straight across and are fastened to each side of the back-bone with one eight-penny casing nail, their outer ends being mortised one-half inch into the lower edge of the side piece; that is, the ribs are mortised in with their bottoms flush with the bottom of the sides, but these mortises do not go though to the outside of the side pieces. See illustration 6. The outer ends of the ribs are fastened to the side pieces with one eight-penny casing nail in each end.

[CONCLUDED IN MAY NUMBER.]

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

V. The Floors, Transoms and Seats.

Across the top of the opening which has been left for entrance to the cabin, a piece about 2 in. wide is to be fastened longitudinally on each side of the beam, to fill it out to the level of the sheathing already in place. The top of the house is to be covered with about 8 oz. duck, laid in paint ; it is tightly stretched and brought down over the edge and tacked at close intervals with small copper tacks.

If it is desired, an opening may be left in the roof over the entrance, and a shade fitted over it, but with the height which there is between the floor and roof in this case, it is not considered necessary. A half round moulding of oak or mahogany, about 1 in. wide, is bent around the edge of the house and across, being mitered at the after corner, where the two lengths meet. The canvas should be painted with a priming coat.

The engine bed should be fitted as early as possible, before the floor is laid. In order to do this all the base measurements of the engine must be known. The shaft-hole being already bored, will locate the center-line. A small line or wire is drawn through the hole and fastened so that it lies exactly in the center, thus locating the shaft center : the forward end of this line should be fastened to a cleat nailed across the door of the cabin. The bed logs must, of course, be far enough apart to admit the base of the engine, and at the correct height so that the center line of the engine shaft will agree with the line already in position. A templet, or pattern, of thin board should be made of the inside surface of the bed.

The outline of the lower edge, which fits the side of the boat, may be obtained as follows: A carpenter's level is laid on the stretched cord, taking care not to sag it, the distance to the inside of the bed is measured out on the level, from the cord and the vertical distance it is from the last point down to the skin is measured. These measurements are taken on every frame throughout the bed, and are then laid off from the curvature. The bed logs should run well forward and aft of the engine to distribute the weight and should be tapered down at the ends. Each bed log is 4 in. thick. The pattern, after being fitted, is laid on and the log cut to shape, leaving the lower edge square. The bevel of the lower edge is obtained by trial and should fit neatly in place on the inside of the frames. It is now notched out to fit over the frames on to the plank, and when correctly fitted should lie fairly on the plank all over and stand vertical. The upper edge may now be laid off by the aid of the level, making it the same distance below the cord as the flanges of the engine are below the shaft center. It will be well, however, to leave a small amount for the final fitting.

The beds are secured in place by nails or screws driven up through the plank. Between the beds a cross piece about 3 in. thick is fitted and fastened to hold them vertical, and on the outside two or three knees should be fitted between the beds and frames. Beds fitted in this way are very strong and distribute the vibration of the engine.

The floor of the standing room and cabin is supported on beams fastened across from frame to frame; these beams may be made of common stock $\frac{3}{4}$ in. thick and 2 in. deep. The cabin floor should be as low as is possible and still avoid trouble with bilge water; that of the standing room should, however, be rather high, or otherwise it will be difficult to see over the cabin and the backs of the seats will be so high as to be uncomfortable. It should be about 11 in. above the rabbet on mould No. 4, aud 4 in. above mould No. 7.

The floor beams are tapered off at the ends and fastened on top of the frames, care being taken to have them all in line. It will hardly be necessary to place them closer than every other frame. Beams which fall next to the engine bed will be cut and fastened to cleats on the side of the bed.

Flooring is of $\frac{3}{4}$ in. stock and is laid out and fitted to the side of the boat in both standing room and cabin; the middle boards in the standing room cannot be fitted until the engine is installed.

The inside of the cabin may be either ceiled or left plain, as desired. For ceiling, $\frac{1}{2}$ in. pine stock is used.

A space of $\frac{1}{2}$ in. should be left between the clamps and the upper edge of the ceiling. The several strakes of ceiling are bent around and shaped in the same manner as the outside planking, the edges being beaded. It is fastened in with small nails or brass screws. The ceiling should extend down to the floor, making a fairly tight joint.

Light ports must now be cut in the trunk about 12 in. long and 4 in. wide, elliptical in shape. A compass saw is used to cut them, being started through a $\frac{3}{4}$ in. hole. The inside edge is neatly rounded and on the outside a rabbet is cut about $\frac{1}{2}$ in. wide and $\frac{1}{2}$ in. deep to take the glass. Glass for this purpose should be at least double thick, cut to shape and set in putty.

The tank should be made and fastened in place next; the capacity should be about 20 gallons. A cylindrical, galvanized iron tank can be bought quite cheaply, and is very good for the purpose. It does, however, take up more room than one shaped to the boat. In the latter case, either copper or galvanized iron may be used, but in either case the metal should

be heavy and the joints riveted and soldered. The tank is supported upon brackets and is strongly fastened in place so as not to be disturbed by the motion of the boat. The filling pipe should be carried up through the deck in one piece and have a screw cap, while the feed should have a cock with a union beyond it.

The bulkheads at the forward end of the cabin and the after end of the standing room are of ⅞ in. matched pine or cypress. The boards are fastened to the beams above, and to cleats nailed on the floor. A removable panel should be left in each and fitted with catches or hinges to hold it in place.

Cabin transoms are to be built above the floor, leaving a clear floor space between of about 2 ft. at the after end tapering forward. The transoms should run across the forward end of the cabin—and a board in the top should be made removable, to allow access to the locker space underneath. The front of the transoms should be sheathed up and a ledge formed around the top to hold the cushions in place. The cabin opening should have a jamb fitted around it and be provided with two doors opening outwards. Such lockers and shelves may be fitted in the cabin as may be desired.

Seats in the standing room are to be fitted about 16 in. above the floor ; they are supported on small beams which are fastened to the frames at the back and supported at the front by small turned posts. The seats should be at least 13 in. wide outside of wash rail, and preferably 15 in.

The make of engine to be installed will also make some difference in the arrangement of the seats, some makes of engines being so wide that it will be necessary to cut away the seat on one side abreast of the engine to give a sufficiently wide passage ; the opposite seat, however, should be left intact, as it is convenient for locker space, also to cover the piping. If a large amount of locker room is desired the space under the seats may be enclosed by sheathing up from the floor to the seat, leaving openings either in the sheathing or the seats for access to them.

The rudder may be either a ½ in. iron plate or of 1 in. oak. It is 22 in. square, with the corners rounded off as shown in the general plan. The stock is placed 4½ in. from the forward edge.

If made of an iron plate the stock should be split and the blade inserted and riveted through. If made of wood the stock should be oak, put together with 5-16 in. galvanized iron rods. The piece forward of the stock, and a similar piece aft of it, are fastened first, the rods being riveted over washers; the remaining pieces necessary to complete this size are then fastened to the after piece. The corners are rounded and the edge beveled off fairly sharp. The lower end should preferably be turned down to ½ in. to allow the insertion of a split pin below the skeg. The top is squared for the tiller with a ½ in. hole above the latter. The tiller should be about 15 in. long with an eye in the outer end to take the wheel ropes. It may be forged and drilled by a blacksmith and the hole filed out square by hand.

The skeg is of ½ in. x 2 in. flat galvanized iron, with the end turned over as shown in general plan ; the space between the bend and the straight part being 1 in. A hole is drilled in the bend to take the lower end of the rudder stock. It is fastened to the bottom of the keel by three ½ in. lug screws.

A piece of ⅝ in. half round galvaninized iron is fastened on the face of the stem, running well down on to the keel.

All the varnished work should be treated to a coat of shellac, sandpapered, and given two coats of best spar varnish. Only the best varnish should be used, as a poor quality will allow the weather to get into the wood and stain it. The painted parts should have two coats after the priming, all the seams in both bottom and top sides being carefully puttied.

The bottom is painted with some kind of non-fouling paint, and it is advised that the water line be struck an inch or two higher than shown in the plans, so that the topside paint may not come near enough to the water to be fouled.

The arrangement of the boat as outlined, is, of course, for general guidance, and any changes may be made to suit any particular requirements of the individual builder.

The directions already given should enable the builder to complete the hull and the directions for installing the motor will be given in the next chapter.

SUITABLE CLOTHING FOR BOYS.

A head master of one of the oldest schools in Surrey, the Kingston Grammar School, upon assuming charge recently, addressed a letter to the parents of his pupils urging the adoption of a more rational dress for boys, and the letter has been given to the press. This schoolmaster asserts that the vest, or waistcoat, is no protection to the most vulnerable part of the body, the back, because the hinder part of the waistcoat is not of wool or a heavy material, while the tightly buttoned vest prevents the fullest increase of chest growth. He advises parents to dispense with the waistcoat and to clothe their boys in sweaters and flannels; in his opinion a flannel shirt and and flannel collar with a tie would be smart and pleasing. While acting as master at Lorretto school, at which the boys dressed as suggested and were enabled to take active exercise at any time without running the risk of taking a chill, he observed that the average school boy became "larger limbed, broader chested, and on the whole more physically fit than the average boy at any other public school." Bicycle rides to school and the various physical exercises and outdoor sports result in much perspiration, and if a linen or cotton shirt or cotton shirt waist is worn there is constant liability to colds.

BOOK-BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

IV. Arranging the Signatures.

In most families are to be found numerous magazines which are not valued to the extent of going to the expense of having them bound up at a bindery, but are, nevertheless, well worth the time and slight cost necessary to binding them at home. In many instances, book binding begun in this casual way has been found of so much interest, and the worker has acquired such skill, that bindings of most artistic and mechanical skill have been executed, and a library of choice bindings eventually acquired.

It will be the purpose of these articles to direct the reader along the first stages of this artistic occupation, but sufficient information will be given so that continued progress can be followed intelligently, and with a proper understanding of the lines along which to study.

A start will be made, therefore, by describing the processes to be followed in binding a set of magazines, and that the illustration may be familiar to us, we will take the numbers of AMATEUR WORK for one year, and comprising a volume. Other magazines will vary but little from this one, and no difficulty will be found in working them if these directions are followed. It is assumed that before commencing the work of binding the reader will have provided himself with the necessary tools, which may be purchased of dealers in bookbinders' supplies, or that he will have made them, as described in previous numbers of this magazine. The sewing frame, described in the September, 1902 ; the press, December, 1902, and cutting press and plow in the February, 1903, issues, are all necessary tools ; the cutting press and plow can be dispensed with if a printer friend with paper cutter can be prevailed upon to do the trimming, but as work of this class works havoc with the knives, a refusal may be expected at the second visit.

The first work is to look over each magazine carefully, smoothing out folds or wrinkles, mending torn places with gummed paper specially prepared for this use and obtained at the public libraries if the stationer does not keep it. Also observe if plate illustrations are correctly placed, that no pages are missing, and that colored illustrations are protected by thin, strong sheets of tissue. Further directions for handling colored plates will be given later.

An examination of the method of binding or stitching each magazine is next in order. AMATEUR WORK being wire stitched in two places, the several sheets making up one magazine being assembled one within another; "saddled" as it is termed, the whole making up what in the book will be termed a "signature". Other magazines will be found bound with wire staples driven through the sheets from top to bottom, near the edge, and others are stitched with thread in several different ways. The two latter classes of magazines generally have several signatures to each magazine, each signature being handled separately when being stitched for binding into a book.

The wire staples, or threads, as the case may be, must be carefully removed, using care not to tear the folds of the leaves. If glue has been used for attaching a cover, the application of hot water is necessary, or the glued surface can be held in the steam from the nose of a teakettle, but should be protected by strips of wood along the edges, held by clamps, to prevent the moisture from working back onto the page and damaging it. After wetting or steaming, the edges should be allowed to dry thoroughly before further work is attempted as, while moist, the sheets will tear very easily. The glue, when moistened as directed, should be scraped off with a dull knife, followed by a moist sponge. The signatures are then separated and laid upon a flat surface to dry, being collected again in the original order when dry.

Again examining the several magazines which are to make up one volume, it will frequently be found that the margins are not uniform at top or bottom. When this is the case, it is necessary to so arrange them that the margins will be alike, so that the book will "register". First find the magazine or signature having the least margin at the top, measure the distance from the headline to the top edge of the page, then mark on the back of each signature a guide line giving the same top margin. When assembled for sawing cuts for the stitching, these marks should be in line, giving to the book an even register.

The handling which has thus far been given the sheets will have the effect of making them lie loosely together, and be more or less wrinkled. To compress them and smooth out the pages, the signatures comprising a book are jogged up evenly at the back and put in the press, where they should remain over night under heavy pressure. Colored illustrations, especially if of recent print, would become attached to the pages facing them if not suitably protected while in the press. In binderies, sheets of tin (not tinned iron) are placed over colored plates, but for the occasional use of amateurs, the oiled paper used for wet copying of correspondence and obtainable at most stationery stores, will serve the purpose as well. As they are so handily obtained, their purchase can be deferred until the necessity for the r use arrives.

As the reader who engages in book binding will, in all probablity, have several books in process at a time, to assemble them in the press it is necessary to have a supply of pressing boards, varying in size for the different sizes of books to be bound. They are smooth, rectangular pieces of maple, or birch or other fine-grained, hard wood, from ½ to ¾ in. thick, and about 1 in. larger on all sides than the books they are used with. They should be very smooth and even. The top block nearest the screw should be about 2 in. thick. The books to be pressed are piled one upon the other in the center of the press, separated by the pressing boards, as illustrated in the description of the press. Care must be used to get the pile as near the center as possible, so that the pressure of the screw will be applied evenly. If a book be thrown out of shape in the press by being placed to one side, it will be quite difficult to again get it to remain even.

To the reader who has but few books to bind, and who is not desirous of fitting up a press as described, a book or two can be pressed by means of wooden hand clamps, such as are used by cabinet-makers for gluing up work, and pressing boards rather thicker than as above specified. An enterprising friend of the writer made use of a bench vise with thick boards each side of the book, and binding only one book at a time.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

VIII. Inside Grinder Head for a Lathe.

If you have ever tried to make an accurate fit in the case of a plug entering a hole, you have doubtless met with considerable difficulty. There are many methods used in machine work for making true, circular holes, but none approaching the inside grinder in results attained. A well sharpened reamer will do a beautiful piece of work when properly used, but after a reamer has once entered a hole and performed its work, it is very likely no longer to size, although the wear may be imperceptible. But continued use of this tool will soon place it in a position where it will be impossible to do a good job with it at all. And then, again, the reamer has its limitations. Unless the hole has a considerable depth, it is very difficult to make the reamer follow true ; it has a tendency to cut on one side or the other, depending upon how nearly vertical it is held, and if it is being driven by hand. This does not happen so frequently, however, when the reamer is used in a lathe and resting against the tail center.

But when it is necessary to make a ground fit, a fit that will allow of perfect freedom of movement and still allow no shake, then it is necessary to resort to a more accurate means of finishing the hole. This is the duty of the inside grinder, and it is indeed wonderful to see some of the classes of work that are done daily on this little tool. And then, again, the time saved is a very important factor, for by no other method can an equally good job be accomplished.

The inside grinder runs at a very high speed, far greater than that necessary for the outside grinder. This is due to the fact that the cutting speed of a wheel depends upon the velocity with which the surface of the work and the particles of emery pass each other. The higher the speed, naturally, the faster will the small particles cut into the comparatively soft steel or other metal. In the case of the outside grinder we have a wheel varying from two to three inches in diameter, while the wheel on the inside grinder is about ½ in. or less in diameter. The circumferences of any two circles are directly proportional to their respective diameters, and if we have an outside wheel that is 3 in. in diameter and running at 3,000 revolutions per minute its peripheral speed will be

$$3 \times 3.1416 \div 12 = 2356 \text{ feet per minute,}$$

while for the half-inch wheel to attain the same peripheral velocity will require a speed of

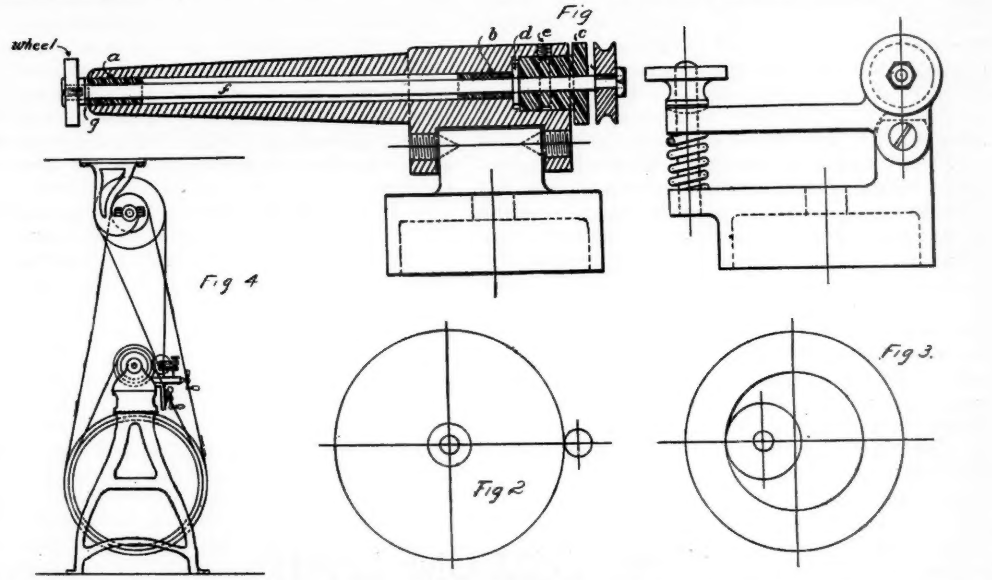
$12 \times 2356 \div .5 \times 3.1416 = 18{,}000$ revolutions per minute, or the revolutions vary inversely as the respective diameters of the wheels. It is seldom possible for the amateur to run his grinder at any such speed, and it is not necessary, as we will learn later.

Let us first look into the construction of the inside grinder. In Fig. 1 is shown a very simple but highly efficient inside grinder head complete with a micrometer adjustment. The base and micrometer arms are similar to those described in the last chapter. It may be well to state at this point why a combination tool grinder is not good for this class of work.

First and foremost, no tool carriage has a feed screw sufficiently fine to take cuts .0005 in., as the movement of the handle would be almost imperceptible to the touch. Then again, such a tool would at times be used for outside grinding and the bearing bushings would soon become worn (this is with reference to that type wherein the spindle may be worked to and fro with the hand) so that a clearance of .0004 in. or .0005 in. would exist, caused by fine particles of abrasive being carried in on the spindle and then grinding out the bushings. Now, when one attempted to use this on a very fine piece of work, either inside or out, he might be surprised to find out how much 2 × .0004 in. really means in close work.

It also requires more pressure to make an inside cutting wheel take hold of the work than an outside

wheel. This is for the following reason: In Fig. 2 is shown the action between a piece of work and the outside wheel. The points of contact form a very narrow line, and it takes very little pressure to make the grains cut keenly. But now look at the case shown in Fig. 3. Here we have a half-inch wheel cutting inside of a one-inch hole. Notice how large the arc of contact now becomes. It takes considerably more pressure to make all these grains bite into the metal than in the case of Fig. 2.



Now, if we were to place this little wheel on the end of a rapidly revolving spindle that overhung its bearing by say, three inches, and presented it to the work, we would find that the pressure that we were required to place on the spindle would bend it slightly, and as the wheel gradually took a deeper cut under the spring of the spindle, the hole would soon be ground with anything but a straight side or of a uniform diameter.

This leads us up to the design adopted in Fig. 1. Here the bearing is carried in an arm that extends close up to the wheel, thus taking all the bending strains, and, since it is necessary to have it only a little smaller than the diameter of the wheel, it can be made strong enough to be quite stiff against such strains. This arm carries a hardened steel bushing, *a*, at the end, and another at the center of the stock. These form the principal bearings for the spindle, which is made of tool steel, hardened and ground so that it runs with absolute truth. A soft steel or composition sleeve nut enters the stock at *c*, and bears against the shoulder *d*, preventing end play in the wheel. A small set screw, *e*, prevents the nut from backing out. This sleeve may be lined with a steel bushing, but the bearing is so long that it is hardly necessary, and the pull of the belt cannot be transmitted to the spindle and wheel, owing to the intermediate bearing, *b*. When the head is assembled, a quantity of thin oil is placed in the annular space, *f*, which keeps the bearing *a* and *b* well lubricated. It is an excellent scheme to keep a small felt washer, *g*, between the wheel and bearing *a*, to prevent the very fine particles of abrasive reaching the bearing.

As the spindle heats, as they always do under such high speed, the expansion is taken care of by the collar *d*, which allows the spindle to lengthen in either direction, but at the same time prevents end play. A very light belt is used to drive this grinder, and for this reason a twisted rawhide belt is far better than any other, owing to the grip that it takes on the pulley. Otherwise, the design is similar to that shown in the last chapter.

These grinders require an overhead drum or pulley, as shown in Fig. 4. This is simply a drum supported by two hangers and driven by a belt from the driving wheel of the lathe. The back gears of the lathe are thrown in, and the work is driven at a very slow speed, while the small wheels must be driven as fast as it is possible with foot power.

The drum may be made of a series of wood strips glued together to form the drum and afterwards turned in the lathe. As these strips are laid together the ends are nailed to the two flanges at the ends, and after all the strips are in place a cord is wrapped tightly around the whole, binding them all closely together until the glue is dry. It is then swung in the lathe and a small tool fitted to the tool post, having a very keen edge. A fine feed may then be used and the piece driven at a good rate of speed which will make a very nicely finished drum, especially after sandpaper has been applied. The drum need not be over six or seven

inches in diameter.

The lead of the belting is shown in Fig. 4. If the drum is over three feet above the lathe, the increase and decrease of tension in the grinder belt will not matter much, but under that the strain will become greater as you feed away from the center. This can be accommodated by unhooking the two ends, untwisting slightly, and again joining together.

Now let us consider for a few minutes the question of the selection of the wheel. Perhaps in no other department of machine shop practice is there such a widely varying result gained from the use of two similar tools as that obtained by the use of different grades of emery wheels. Emery wheels are graded in two ways; first, as to their degree of fineness, running from No. 8 to 120, the former being very coarse and the latter very fine, and second, as to their relative hardness. This degree of hardness is denoted by the letters of the alphabet, A denoting the softest grade.

The hardness of a wheel depends largely upon the amount and character of material used in making up the wheel. Generally speaking, a wheel composed of fine emery is more compact and harder than one made of coarser emery. Softness is the most important characteristic in a wheel, as a soft wheel will be less likely to affect the temperature of the work or to glaze, and is best for grinding hardened steel, cast iron, brass, copper and rubber. For soft steel and iron, use a harder and more compact wheel. It might be said that the harder the work the softer the wheel required to give a certain finish.

The thickness of the wheel or width of the surface presented to the work also controls the degree of hardness to a certain extent. The narrower the wheel the harder should be the grade.

Below is given a table of the numbers representing the various grades of emery, and the degree of smoothness of surface they leave may be compared to that left by flat files as follows:

8 and 10	represents the cut of a wood rasp.
16 and 20	" " " " a coarse rough file.
24 and 30	" " " " " an ordinary rough file.
36 and 40	" " " " " a bastard file.
46 and 60	" " " " " a second-cut file.
70 and 80	" " " " " a smooth file.
90 and 100	" " " " " a superfine file.
120F and FF	" " " " " a dead-smooth file.

The following table gives the average speeds for emery wheels as taken from the lists of various manufacturers:

Diam. of wheel	Rev. per min.
1 in.	15,000
1½ "	12,500
2 "	10,000
2½ "	8,000
3 "	7,000
4 "	5,000
5 "	4,000
6 "	3,600
7 "	3,000

As a general rule, the peripheral speed of a wheel should be about 5500 feet per minute.

THE OSMIUM LAMP.

The following is an abridged translation of a paper on the osmium lamp read by Herr Fritz Blau before the Elektrotechnischer Verein, of Berlin, on January 24:

The total energy radiated by a heated body is proportional to the fourth power of the absolute temperature of the body. As the temperature increases, the percentage of the short waves emitted, as compared with those of long length radiated, increases also very rapidly ; but the absolute value of this percentage varies for different bodies, being smallest in so-called " black " bodies, but comparatively high in bodies with a metallic lustre and a smooth surface. Only these short waves, it need hardly be said, are observed as light. An efficient light-giving body must, therefore, withstand very high temperatures; its radiating surface, at a given efficiency, should be as large as possible; the substance of the filament should be transparent or white to minimize the effects of blackening; the surface of the filament should not become blacker or rough with use, and its resistance should increase with increasing temperature.

Osmium, generally in the form of osmium-iridium, is found in platinum ores and also in gold and silver. It is at present usually obtained by alloying the residue which remains when platinum is dissolved in aqua regia, with metals, such as zinc, lead or tin. The osmium-iridium passes thereby into a finely divided state, and if it is now heated in a current of oxygen it will split up into osmium tetroxide and iridium. Osmium may then be obtained by treating the osmium tetroxide with any reducing agent.

When Herr Auer von Welsbach invented the osmium lamp some six years ago, he found it impossible to draw osmium in form of wire, and he first tried the expedient of coating platinum wire with osmium and evaporating subsequently the greater part of the platinum. It was observed, however, that a platinum osmium alloy was formed which—when containing more than four per cent of platinum—began to melt when the platinum was being evaporated. In order to keep percentage of platinum below this figure, the finished filament had to be made about five times thicker than its platinum core. As uniform platinum wire was not obtainable in thickness less than 0.02 millimetre, it will readily be seen that the osmium filaments could not

advantageously be made in diameters below 0.1 millimetre. Such filaments, however, are not suitable for lamps consuming less than one ampere.

The next and final step was to mix most finely divided osmium with certain organic binding substances to a thick, tenacious paste. The paste is forced under high pressure through a diamond or sapphire die on to a card which is moved about in such a manner that the filament is deposited in loops. After drying, the organic binding substance is carbonized by heating the filament in vacuo. This porous filament, rich in carbon, is gradually heated to an intense incandescence by an electric current in an atmosphere containing much steam and a certain quantity of reducing gases. The carbon of the raw filament changes into carbon oxide and carbon dioxide, and after a relatively short time the filament consists of pure, or very nearly pure, osmium only, the percentage of carbon being insignificant. Although the density of the filament has greatly increased during this process, the filament is still porous and its surface is far from smooth. After trying unsuccessfully several means of connecting the filament to the platinum leads, it was found that a very satisfactory method was to fuse them together by the electric arc. Osmium is brittle when cold, but soft when heated, and for this reason the lamps as made at present, are required to burn in a definite position.

When the manufacture of this lamp was taken up by the Deutche Gasgluhlicht Actiengesellschaft, the highest voltage that the lamp could stand was twenty-seven volts. After the lamps had been perfected to burn at thirty-seven volts they were put on the open market. The lamp voltage was soon after brought up to forty-four volts, and during the last few months a considerable number of fifty-five and seventy-three-lamps have been sold. Quite recently 110-volt lamps have appeared.

The filament of an osmium lamp for thirty-seven volts, twenty-five candle-power (Hefner units) consuming one and one-half watts per candle-power, has a diameter of 0.087 millimetre and a length of 280 millimetres. The radiating surface is from three square millimetres to 3.2 square millimetres per candle-power. If an ordinary glow lamp be run at one and one-half watts per candle-power, its radiating surface per candle power is only 1.6 square millimetres. The carbon filament, therefore, must be both hotter and "blacker" than the osmium filament. With an increase of voltage of ten per cent the current increases 6.5 in the case of the osmium lamp and twelve per cent in the carbon filament lamp. The corresponding increase in illuminating power is forty per cent and eighty per cent, respectively.

It is not possible to state definitely the life of the osmium lamp, but 5000 hours have been repeatedly exceeded. Blackening of the bulb is very rare; (observed in ten per cent only of the lamps investigated so far. The surface of the lamp filament is at first somewhat rough, but it gradually becomes smoother, and this is the reason why the candle-power increases durins the first 250 hours or so. Before the lamp is ready for sale it is burned in the factory for several hours in order to bring the lamp up to an approximately steady state.

If the lamp is run at less than one and one half watts per candle-power, the structural changes in the filament occur too rapidly for practical purposes. Nevertheless, lamps consuming one watt per per candle-power only have been observed to burn for several hundreds of hours without decrease in light. When exposed to hard shocks, the osmium lamp filament is somewhat more liable to break than the carbon filament, but if properly packed the loss through breakages in transit is small, being only about one and one-half per cent. These lamps stand the shocks of railway carriages and omnibuses very well. The osmium lamp is efficient also for very low voltages, and a large number of two-volt lamps for mines are in use in connection with portable accumulators. For a long time it was not possible to make thin filaments, but recently it has become feasible to reduce the diameter down to 0.03 milimetre—*Electrician.*

NEW OZONE GENERATOR.

A new ozone generator has been recently brought out in London and is described in the *Electrical Review*, of that city, for November 11. The apparatus consists of a mahogany box about 16 x 28 in., lined with asbestos board. At one end is a small electric fan producing the necessary circulation of air. Several baffle plates are placed within the box, on which the ozonizing girds are fixed. The box also contains a small step-up transformer for producing the necessary high potential.

The baffle plates consist of thin sheets of highly insulating material, such as micanite, on each side of which sheets of copper gauze having forty meshes to the inch are fixed. These sheets are connected alternately to the two poles of the step-up transformer, which gives a potential difference of 4,500 volts, this having been found by experiment to be the best pressure for the purpose. The ozonizing surfaces have an area of about four square feet. As at each corner of each mesh of the gauze the wire is necessarily bent so as to form an elevation, which may be regarded as a round-point, there are 230,400 such points to a square foot of the ozonizing surface, giving a total of over 900,000 points in the apparatus from each of which a discharge takes place. Owing to this extreme subdivision of the discharge there is said to be no sparking and no formation of nitrous compounds. It is said that this apparatus is capable of ozoning 30,000 cubic feet of air per hour, with an expenditure of sixty watts, including all the losses.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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APRIL, 1905.

The relation of the school system of a country to the welfare of the public is intimate. Indeed, it is of vital importance that proper educational facilities be provided, that all may find it easily possible to acquire that education which will enable their natural abilities to be developed to the utmost. It is a fact, unfortunately, that school life is commonly looked upon as something more or less apart from the practical, productive work which begins when the former ends. Not only is this idea wrong, but the very fact that it is more or less prevalent is, in itself, harmful, as it acts to prevent many who would be greatly benefited by educational work from becoming interested in it, and so utilizing present facilities, and also discouraging the undertaking of addional ones.

This condition is undoubtedly due, in large measure, to the chaotic state in which industrial educational methods now are, and the additional fact that comparatively little intelligent effort is at present, put forth to better matters. This, in turn, is undoubtedly because of the rapid and transforming changes which have recently taken place in the industrial world, and the inabilty of of educational methods to become readjusted to the new requirements. As the industrial changes are still in progress, it is also rather difficult for those who have not given special study to the subject to determine exactly what are the lines on which educational work shall be developed, and as the number who have realized the urgent necessity of comprehensive industrial educational facilities is not yet large, and the discussion of the subject but recently become in any way general, no systematic effort has yet crystalized to the extent of formulating plans for such work.

That we are on the eve of a general awakening to the importance of the subject seems evident; that it may be speedy and fruitful of results is earnestly to be desired. For in no other way can the youth of the country be brought to that condition of skill and experience which will fit them for the higher and more profitable vocations open to them if given the facilities by which they may become competent. It is the earnest duty of all, therefore, to encourage the expansion of our educational system, especially along industrial lines, so that opportunities for advancement dependent upon educational progress may not be confined to the rich, but rather that merit be given an even chance in the race, which can only be when industrial education is comprehensive and within the reach of all.

We have but to look to the magnificent industrial educational work of Germany to realize how great are our own necessities, and the need of immediate action.

The Vienna *Workingman's Journal* reports that at the general meeting of the Mineralogical Society of Vienna, January 9, 1905, Dr. Morosiewicz, professor of of mineralogy at the University of Krakau, announced that he had discovered a new mineral, to which he had given the name Beckolith, in honor of the Vienna mineralogist, Prof. Friedrich Beck. He asserted that it does not correspond to any of the mineral combinations so far known, but resembles mostly combinations of garnet, having similar regular crystals, and contains many rare earths, which form 75 per cent of its volume. The chief components are cero, lanthano and didymo oxides, and it may be of use for the manufacture of chemical products, especially for the light industry. The discovery was made during a scientific exploration which Prof. Morosiewicz made in southern Russia, and the government district of Rekaterinoslaw is probably the chief locality where the mineral may be found. The rock in which it was discovered is called marinpolith.

Every amateur mechanic who wishes to keep posted should regularly read AMATEUR WORK.

A REFRIGERATOR.

JOHN F. ADAMS.

Winter has but just left us, yet it becomes necessary to think of summer and the ice man. This leads up to the subject of a refrigerator, the one here described being a size and design suitable for family use. The reader need have no hesitation about using this style of construction, as one like it has been in constant use for over four years and is still in excellent shape for use at least as much longer. The cost for lumber will vary from $6 to $8, and the zinc, shellac and fittings will cost about $2 more; the finished refrigerator being quite equal to any $25 article which can be purchased, and much superior to many.

The chopped cork, used for the packing, is readily obtained for the asking of any fruit dealer handling Malaga grapes, but it would be well to obtain it at once, as the grape season is about over, and as the cork is thrown away it cannot be obtained readily very much longer. About a grape keg full will be required. It is much the best thing which can be used for packing, keeping dry and odorless even after many years of use.

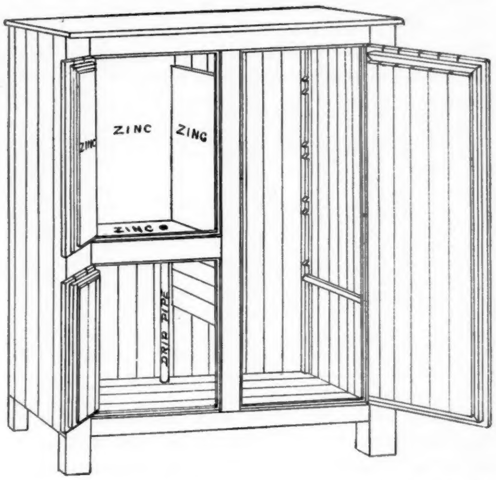
The lumber bill includes the following:

40 sq. ft. spruce sheathing, ½ or ¾ in. thick.
40 " " gum-wood " " " " "
36 ft. 2 x 3 in. spruce, planed all over.
1 piece gum-wood, 36 x 24 x ⅞, glued up.
1 piece oak, 20 x 12 x ¾ in.
2 " " 19 x 10 x ¾ in.

Gum-wood for the outside sheathing gives a fine appearance, but costs more than spruce, which may be substituted if desired. In addition will be needed 3 pieces of zinc or galvanized iron 19 x 24 in. Also three pairs brass hinges and three refrigerator door fasteners, the latter being found on sale at large hardware stores.

With these materials at hand, first make two frames of the 2 x 3 spruce, which after being planed will measure about 1¾ x 2¼ in. Cut four pieces 33 in. long, and four pieces 22 in. long; make halved joints at the ends and nail firmly, the larger dimensions of the stock being vertical. One of these will be for the top and the other for the bottom of the refrigerator. With the spruce sheathing cover the under side of the top frame and top side of the bottom frame, the sheathing being brought flush to the sides of the frame, except on the front, where it covers only 1 in. of the frame, with places cut out for the posts next to be mentioned. The front strips of sheathing are not nailed in place, therefore, until after putting in these posts.

Cut three pieces of the 2 x 3 in. spruce, 36¼ in. long, one for each corner and one for the center, as shown in the illustration. Also cut a piece 24 in. long, for the cross piece between the ice and lower chamber on the left. The lower edge of this cross piece should be 24 in. above the lower frame, and the ends are halved into the uprights. Before fastening in place cut a groove ⅞ in. wide, ½ in. deep and 12 in. long in the center of the inner surface, beginning at the center post, to receive the end of the oak pieces forming the floor of the ice chamber. The joints should be glued, drying in clamps.



Prepare strips of ¾ in. stock 1½ in. wide, and firmly screw same to the sheathing at the ends and back of both upper and lower frames. The ends of the inside sheathing are nailed to these strips.

The erecting can now begin by nailing the three posts onto the lower frames, the cross-piece above mentioned being in place; the upper frame is then put on, temporarily holding same at the back by nailing strips to both lower and upper frames.

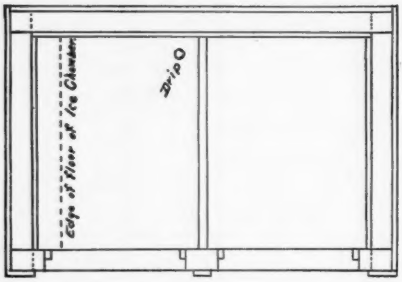
The inside sheathing is then nailed in place, using wire finish nails and blind nailing as much as possible.

The corners are made as tight as possible. If the joints are glued when matching, less moisture will work into the wood, which is an advantage.

The floor of the ice chamber is next put in place. This is made of an oak board about 19 in. long and 12 wide, the right edge being brought flush against the center partition, leaving a space about 2 in. wide at the left, through which the cold air falls to the chamber below. A slight slant must be given this floor piece towards the inner, center corner, where is located the drip pipe. A hole 1 in. diameter is bored in this corner, centering 2 in. from the right edge and 1 in. from the rear end. This hole should be bored before fas-

tening the board in place, which is done by nailing through the sheathing and the first cross piece. The center partition is then put in. It is of $\frac{3}{4}$ in. sheathing, and begins 4 in. from the under side of the top, and continues down to about 6 in. from the bottom, leaving these spaces for the circulation of the air.

Directly under the hole in the ice chamber for the drip pipe in the floor of the lower chamber is bored a 1 in. hole for the drip pipe. In a piece of the 2 x 3 in. spruce about 4 in long, bore a 1 in. hole and nail the piece to the under side of the sheathing, boring a hole to meet same in the sheathing put on under the lower frame. See that the holes in sheathing and block are in line and straight, making a firm, tight fit for the pipe. The sheathing on the under side of the lower frame is then put on. To do this, lay the whole frame on the back and begin at the back edge, the first strip of



sheathing being put flush with the lower edge. Before fitting on the last two strips begin the packing with the chopped cork. Put in enough to fill the space to a depth of about 6 in., tamp it down with a stick, not too hard, or it will force out the sheathing, but firm enough to prevent spaces being formed by subsequent moving about of the refrigerator. Keep adding the cork and tamping with a stick until all the space is filled, putting on the last strip of sheathing and covering the narrow space then remaining after filling as full as possible with the cork chips.

The two ends are then sheathed in the same way, beginning at the back and placing the first strip at each end so as to cover the edge of the sheathing on the back. The back sheathing is then put on, laying the work on one end to do this. Should the sheathing show a tendency to bulge out, put in a short piece of the 2 x 3 in. spruce and fasten with long screws of small gauge from both inside and out. The top, 24 x 36 in. is then put on, after firmly packing the space with cork, and securely nailing to frames and sheathing.

The front is then finished off by putting strips across the top and bottom, along each side, down the center and on the cross piece, these pieces being the proper width to allow the posts and cross piece to expose a margin of about $\frac{5}{8}$ in., and forming a jamb to the doors, serving in part to make them air tight. Strips $\frac{3}{4}$ x $\frac{1}{2}$ in. are also nicely fitted around the inner edges of the door making a second jamb, and giving tight doors.

Under each corner, legs 4 in. high are screwed. These can be made from pieces of the 2 x 3 in. spruce.

The ice chamber is then lined with zinc or galvanized iron, after nailing to the left edge of the floor a strip of oak $\frac{1}{2}$ in. square, which acts as a stop to the water from the melting ice. If the reader is not used to such work a plumber should be employed, who can do all the work in a couple of hours if the pieces have been cut and fitted ready for him. The drip pipe fits over the end of a short piece soldered to the lining of the ice chamber, and can be formed up from a piece of the zinc or galvanized iron. At the lower end, which projects below the under side, a V shaped cone is made having three upright strips soldered to it, which enter the drip pipe and hold the cone in position. This fills with water and acts as a seal to prevent cold air from escaping from the ice chamber.

The doors are made as follows: Frames are made of stock 1 in. thick and 2 in. wide, the corners being mitered and then sheathed front and back, the latter being put on last and the space filled with cork as before described. The front sheathing laps over about $\frac{5}{8}$ in. all around, and the back sheathing is short $\frac{1}{2}$ in. on all sides. All joints should be well made, and the doors a good fit, without being so tight as to bind as they may swell a little from moisture.

In each corner of the large chamber, strips of spruce $\frac{3}{4}$ x $\frac{1}{2}$ are firmly nailed; the edges of these strips have slots cut in them at suitable places in which rest the ends of the cross pieces holding the shelves. The shelves, if made of wood, should not be much over one-half the depth of the chamber in width, and when in use should have a small air space at the back to give proper circulation. If the whole capacity of the food chambers are needed, then shelves of wire netting or perforated zinc, should be made by fitting the wire or zinc to a frame made of rod iron, painted with alluminum paint to avoid rusting.

The inside is then given two or three coats of spirit shellac, using only the best grade and allowing each coat to dry thoroughly before applying the next; work the shellac into all joints aud cracks so that there will be no places for moisture to work into the wood. An additional coat of shellac will be needed after the first season's use.

The hinges and fastenings are then fitted. For catches, get the kind with drop handles that work on a cam, which will bind the door tight when closed. Ball bearing castors on the legs make moving about an easy matter, the completed refrigerator being quite heavy. The outside is finished with a natural filler and then shellacked and varnished.

Wood is now seasoned by the use of electric current, the sap being drawn out and borax resin drawn into the pores of the wood in its place by electrolysis.

Renew your subscription before you forget it.

PHOTOGRAPHY.

PORTRATURE BY DAYLIGHT

IN AND OUT OF DOORS.

Only the merest rudiments of this very interesting occupation can be touched upon.

But within the space at our disposal we can, firstly, put the reader on his guard against the special dangers of indoor portraiture—dangers which do not readily occur to those who for the first time set up their cameras in the house ; and, secondly, give him some hints on the quite opposite difficulties of portraiture out of doors.

INDOORS.

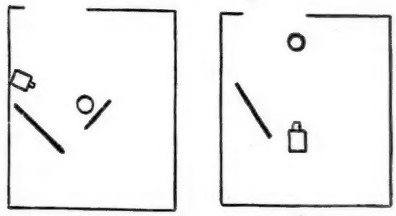
Indoors.—For purposes of practical work do not let us limit "Indoors" to sitting-rooms, drawing-rooms or other apartments of the home. The opportunities for portraiture occur in many other places than these—in the shop of carpenter or cobbler, or in the schoolroom or in the inn parlor. The ruder and rougher the building, the better for our photographic purpose ; the array of glittering knick-knacks in the drawing-room, as it is furnished by the young matron, being one of the minor obstacles in the path of the indoor photographer.

Lighting.—One window being usually the only source of light, it is soon discovered that the lighting of the sitter can easily be wrong. The most common mistake is to place the sitter sideways with the window and fairly close to it, with the result that one side is in strong light and the other in deep shadow, with little gradation between these two extremes. The effect is a hard or "chalky" portrait, not calculated to display to advantage the features of any but the most rugged Irving or Martin Harver type of countenance. On the other hand, if the sitter's face is fronting the window the light is the same all over the face, and the result is a corpse-like flatness, perhaps the worst sin of indoor lighting that can be committed.

The chief secrets of obtaining a pleasing modelling on the face are:—(1) A position for the sitter not near to the window, say 5 or 6 ft. from it ; (2) a reflector on the shadow side of the face ; and (3) softening the strong light coming through the upper part of the window. This latter casts heavy shadows under the eyes, nose, lips and chin. We can get rid of this top light altogether by going far enough back into the room, but then we lose the relief which it gives. With the sitter in a position nearer to the window the top-light is screened by pinning tissue paper over the window frame or using a screen (say of muslin stretched on a child's hoop) above the sitter.

Figure *a* shows how camera, sitter and reflector may be placed, and is offered as the roughest hint as to arranging matters in an ordinary room.

The Background.—The wall or interior of a room is almost always the worst of backgrounds, unless stripped of ornaments and prominent objects, which, by hook or crook, manage to show up somewhere behind the sitter's head most prominently, causing us much work before they can be removed from the negative. Smooth brown paper damped and mounted on a clotheshorse or a framework made for the purpose, forms a good background. For a lighter one a blanket will answer well—a white sheet is too light—or a light-colored traveling rug. One little dodge about backgrounds may be mentioned here, and that is on using some rug or drapery of prominent pattern when a a plain background is wanted. It is really very simple. Get some one to gently move the background a little up and down and side to side during the exposure.



a. *b*

The reflector is a big piece of white cardboard or a white sheet stretched on a frame. It is all the better to have the reflector pivoted so that it can swing from its center like a bedroom looking-glass. The movement is convenient in tilting it towards or away from the sitter.

The Lens and Camera.—The largest aperture the lens can be opened to may safely be used for portraiture indoors, that is to say *f l* 8 : or *fl* 6 is none too rapid.

The danger of indoor work is under-exposure, and as the exposure must not be long—to avoid movement of the sitter—there is need of a large aperture and a fairly rapid plate. In this as in all portraiture, it is well to use a lens of the longest focal length permitted by the distance between sitter and camera. In many rooms this is not greater than the orthodox 5½ in. for quarter-plate, but it is better to have longer if circumstances allow.

Exposure.—In winter work—indoors or out—use a meter. Useful in summer, a meter is indispensable in winter, when the light falls off after noon with much greater speed than in summer. For indoor work it is convenient to work the meter at the quarter tint, otherwise the time taken by the paper to darken is too great.

In portraiture the beginner must learn to recognize the effects of under and over-exposure : The former accentuating the features of the face, burying dark

parts in one inky blackness, and the latter by the loss of contrast on the face, general flatness, and a lack of difference between tones which were different.

On development there is little to be said beyond the caution to aim at a thin, delicate negative, for which amidol, metol or rodinal is a very suitable developer.

Against the Light.—With proper precautions some most charming effects can be obtained by placing the sitter close to the window, the chief light coming towards the camera and thus putting the side of the face, as seen in a photograph, in shadow. The beauty of this form of lighting depends on preserving the roundness of the face and figure of the sitter, and to do this the reflector must be used to relieve the heavy shadow on the near side; but not too much reflector, or the effect of the straight lighting is lost. A beautiful profile is *the* subject for lighting of this kind, by which also transparent draperies, muslins, chiffons and lace appear with good effect. The arrangement of camera, etc., will be somewhat as in Fig. *b*. Plates should be backed and a liberal exposure be given, so that everything you want in the negative develops easily in about five minutes. In this way halation will be avoided as much as possible.

The fine piece of portraiture of this kind by Mr. M'-Lean may be taken as an incentive and a standard by those commencing indoor work.

Sunshine is susceptible of many strong and beautiful effects, but it wants more skill in management than diffused lighting, and particularly so in small rooms. The wisest suggestion that can be made to those anxious to use it for portraiture is to commence in semi-outdoors, such as a veranda, gateway, or even doorway.

OUTDOOR PORTRAITS.

Indoors the lighting is too strong in one direction—from the window on to the sitter. Out of doors the lighting suffers from an exactly opposite defect—it is too even all round. To obtain relief and contrast we must cut it off on one side or the other. One of the simplest ways of doing this is to place the sitter in the angle of a building where light from behind and from one side is quite cut off by high walls. Then there is probably too much top light, and a light screen of muslin stretched a few feet above the sitter will greatly improve matters. With a second screen at the side we practically reconstruct a regular studio, and some very effective portraiture can be done with such an arrangement ; or better, with the portable studios constructed on the same principle by Tylar of Birmingham and others.

Those who want to study portraiture as it can be done without a studio should fix up a couple of stout parallel copper wires at about 8 feet from the ground and about 6 feet apart. On these can be hung screens of muslin or opaque cloth, with which can be obtained almost any sort of lighting.

Arranging Sitter and Background.—It is worth while to try heads, or half-lengths (head and hands, in a sitting posture), and to make them a good size on the plate instead of confining oneself to full-length figures in small size amidst a great mass of surroundings, as is usual. Choose your background and arrange the camera before asking your sitter to be seated, for until you have gained experience you will be slow, and apt to tire a nervous sitter. Let the background be natural for choice ; and remember that the nearer your main object is to the camera the nearer will be the point beyond which objects are out of focus. As you will probably have to use a large aperture for the portrait exposure, the background must not be a very distant scene, if you want it very sharp. On the other hand, a distant object entirely out of focus will often make a very pleasant soft background of indefinite light and shade.

Artificial Background reflectors.—A white sheet, a plain blanket and plain rugs obtainable in every household, give backgrounds of various tones, so that one can be chosen to suit any subject. Even an apron, or a focusing cloth, if held by an assistant close behind the sitter, may answer as a background. It is best to pin it to a broom handle or walking stick, so that it hangs flat. In some cases, especially in direct sunshine, there are heavy shadows under the eyes, nose and lower lip. These may be considerably lighted up by laying a few newspapers on the floor around the sitter.

Lighting the Sitter.—The lighting must be chosen before the sitter is posed, or even the background selected. It is not well to place the sitter in sunshine, unless you have had much experience of this work (see later paragraph, however). With a generally diffused light, as from a lightly clouded or a grey sky, good portraits can be made almost anywhere, but even in these cases it is well to have something to give a little variety of light and shade to the face, and any building will do this. Suppose you want a full face portrait, with considerable contrast between the lighter and the darker sides of the face, place the sitter within two or three feet of the side of a house and with her shoulder toward the house. The house (of brick or stone) reflects very little light ; and the actinic difference will be more than the visual difference between the two sides of the face. Every foot that the sitter moves away from the house will make the shadow side lighter. For diffused front lighting, place the sitter with her back to the house and facing toward the most open part of the view. Remember that the more nearly you can see the horizon, the more diffused will be your light. The nearer you come to houses or trees, the stronger (proportionally) are your top-light and your top-light shadows. Note what was said in previous paragraph *re* reflectors.

In many cases a soft lighting of the face may be obtained even where the top-light is hard and concentrated, by simply letting the sitter wear a wide-brimmed hat, which takes off the harsh top-lighting and smooths out the wrinkles and shadows as if by magic. A white straw hat often lets through the brim and reflects from its under side just enough light to make a pleasant play.

Again, if your difficulty is that the contrast in lighting between the two sides of the face is too great, this may be overcome by hanging a white sheet (on a clothes-horse or from a broom handle laid on top of a pair of steps) or pinning a few newspapers to reflect light on to the shadow side of the face.

Sunlight portraits may be made very attractive if thoroughly well done, but they require much more careful handling than diffused light pictures. Few faces can stand the photographic effect of absolute sunlight, so that the best results will be secured if the hat, or convenient branch of tree or bush, is used to shade part, at any rate, of the face. The wide brimmed hat, thin white hat suggested in the last paragraph, is very convenient for sunshine work, and will give a shadow that makes a fresh bright face very interesting. With sunlight portraits the background needs careful consideration. It should not be too dark, to contrast harshly with the figure, and should not be too hard and spotty. For sunshine portraits it is well to use a backed plate, which should be very rapid but of considerable latitude (preferably double coated); and the exposure must be ample.

Photogram.

DANGERS FROM ILLUMINATING GAS.

The illuminating gas hazard to life and property is explained in clear and intelligent shape by Fire Marshal Davis of Ohio, as follows:

"The swinging gas jet with more than one movable joint is safe in a building only when the gas is shut off at the curb, and one with a single joint should have a stop on each side to prevent its being turned against goods or the wall, unless it is furnished with a glass globe or wire hood. The fixture which causes the most earnest criticism from fire marshals while making inspections, is the swinging jet used alternately to light the coal bin and the furnace door in city dwellings. They usually find spots of char made by it at some part of the woodwork. A gas jet will first char wood which is too close to it and afterward will fire the charcoal it has formed. One having in mind the fact that charcoal is necessary to the explosion in gunpowder or its liability to spontaneous combustion cannot view its formation over a gas jet or under a gas stove without apprehension. A jet should not be within 2½ feet of the ceiling. The greatest distance at which a gas jet is reported as having set fire to a ceiling is 28½ inches.

Gas does not freeze; neither do gas pipes. What may freeze is the vapor of water carried by all gas in larger or smaller percentages. This watery vapor is condensed as frost on the inside of a cold pipe and may build up enough to close it. A very few degrees of heat will reconvert it into water, and when such conversion takes place, a pipe which may have been temporarily closed is open again and permits gas to pass through. This happens frequently in dwellings and explains why a gas light turned low will sometimes go out and gas be subsequently found flowing through the burner. There are many safe lights for the bedroom, and gas is so unsafe that its use for that purpose can only be attributed to ignorance of the danger it involves at all seasons, but especially in winter. The number of fatalities from the leakage of illuminating gas is not only large but increasing. An investigating committee in Boston found that a moderate increase in pressure caused leakage in 89 per cent of all homes examined. One part of gas with six of air makes an explosive compound.

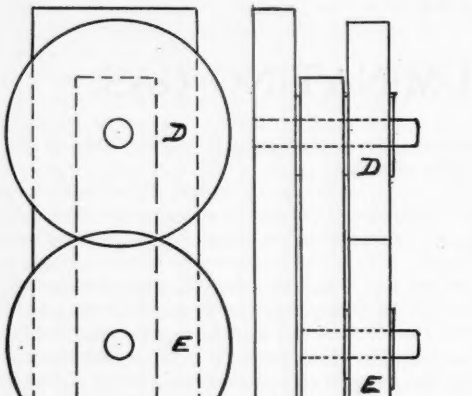
Necessary to the appreciation of the different degrees of danger, from having one of the several kinds of gas in a dwelling, is a knowledge of the constituents of each. When coal is roasted in a retort, coke, tar, ammonia liquor and illuminating gases are produced. These gases are passed from the retort through an iron pipe to the bottom of a large horizontal pipe half filled with water, in which most of the tar and ammonia settle. The gases then pass through a series of tall iron pipes, which cools them; up through a tower filled with coke, down which the water trickles (the 'scrubber'), which dissolves out the ammonia and other soluble gases: then through the purifiers, in which lime and hydrated oxide of iron absorb most of the carbon, dioxide of iron and sulphur compounds; then into the large gas holders.

This product, ready to be pressed into the mains is, speaking broadly, hydrogen one-half, natural gas one-third, with 6 to 11 per cent. carbon monoxide which slays its thousands each year, and 3 to 11 per cent. of heavy hydrocarbon (olefiants). The first three in burning produce heat, but practically no light without the hydrocarbons, which contains ethylene. The fine particles separated from the ethylene by becoming white hot give off light, and, not being entirely consumed, unless the gas is mixed with 15 times its volume of air, part of them float away as pure carbon (soot).

Within a few years the practice of mixing water gas with coal gas, or using it separately in the interest of economy, has become general. This at least quadruples its dangers, as shown by chemical analysis and by the alarming increase in the number of gas asphyxiations. Water gas is made by forcing steam through charcoal which is at a white heat. The atoms of oxygen in the water, which is in the form of steam, unite with atoms of carbon from the charcoal to form carbon monoxide, liberating the atoms of hydrogen. When piped into homes it is 44 per cent carbon monoxide. So 2 per cent of water gas in the air will kill an adult, because .65 per cent of carbon mon-oxide destroys life."

FERGUSON'S MECHANICAL PARADOX.

The remarkable history of James Ferguson, a self-educated man who achieved a prominent place in astronomical circles during the middle of the last century, affords an incident which will be of interest to many readers of this magazine. While engaged one evening in a religious controversy, and to prove his contention, he volunteered to construct a mechanical



device which seemingly was contrary to all mechanical laws and declared as impossible by those with him. He appeared by appointment a week later, however, with the arrangement of gears given in the following description, which greatly mystified his associates, who were unable to solve the reason why the gears moved contrary to recognized laws. The original model made by Ferguson was of wood, and similar ones can easily be made if the directions are carefully followed, which will be a good puzzle for the unitiated to study over and show the extent of their knowledge of gears.

We will first have a description of the device, which the illustration shows to be a train of gears mounted on a frame and which may be turned in either direction by the handle. The gear *D* is a fixed gear, the others turn on their shafts. If the frame be revolved, any number of times, the several gears will presumably be found to mesh at the same places when the frame is brought to the same vertical position, but this is just what does *not* take place.

Of the three gears, *F*, *G* and *H*, one will remain in the same place, another will be found several teeth to the right, and the other several teeth to the left of the position from which it started. This will be made evident if, before the frame is turned a chalk mark is drawn on the top of these three gears, the location of the chalk marks after several turns of the frame showing the movement of two of the gears mentioned above.

The solution of the mystery lies in the fact that the gear *G* has one tooth less, and the gear *H* one tooth more than the others, the teeth on *G* being thickened slightly and on *H* thinned, to run on *E* without binding. That the difference in pitch be as inconspicuous as possible, the gears should have quite a number of teeth. Gears 4 in. in diameter make a good size, and 100 teeth are easily laid out on this size.

To make a wooden model, a supporting board, *A*, is first prepared. This may be 12 in. long. 3 in. wide and ⅞ in. thick. The piece *B* is 14 in. long, 1½ in. wide and ⅞ in. thick. To avoid excessive wear, the shafts can best be made of brass rod ⅜ in. diameter; that for gear being 3 in. long, and for the others 2 in. long. The shaft for *D* is driven with a tight fit into a hole bored 2½ in. from the top of and in the center of the board, *A*. A hole is bored in *B*, the center of which is 1 in. from the upper end and is an easy fit for the shaft, so that *B* may freely turn on it. The gear *D* is a tight fit on this shaft and does not turn. A small piece of wood ½ in. thick is placed on the shaft *A* and *B*, to keep the latter away from the former. The shaft for *E* is driven with a tight fit into a hole bored in *E* and centering about 3¾ in. from the hole for *D*. The locating of the holes for the shafts should be done after the gears are made, that they may be so spaced as to prevent binding or looseness. The shaft for the three gears, F, *G* and *H*, is also spaced about 3¾ in. from that for *E*, and tightly driven in a hole in *B*.

The gear, *D*, should be about ½ in. thick, and the

three gears, *F*, *G* and *H*, each ¼ in. thick. They should be made of well seasoned maple or birch of even grain, which should run parallel with the shafts. They should also be well soaked in oil, after the teeth are cut, to avoid splitting or change of shape. The gears, *D*, *E* and *F*, have 100 teeth, *G* has 99 teeth, and *H* 101 It will also be necessary to make the teeth on *E* rather thinner than that pitch would ordinarily allow. The shaft for the three lower gears should have a small hole drilled near the outer end, into which a stay pin can be placed, holding the gears in position when turning, yet allowing of their easy removal to adjust so that there will be a straight row of teeth at the top of these gears before commencing to turn and upon which a chalk mark can be made, when showing the device to visitors.

The handle is attached to the lower end of *B*. It is evident that, if the frame be turned, the gear *G*, having one tooth less than *F*, will turn on its axis faster than *F* and in the direction it moves on its axis, while *H*, having one tooth more than *F*, will turn slower than *F* and in the opposite direction from which it turns on its axis.

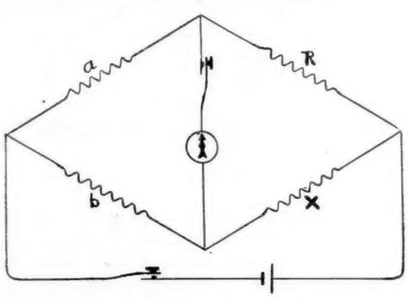
This device offers an excellent study in wood working, as well as an interesting example of the action of a train of gears and will prove of much interest to anyone making it, as well as to visiting friends interested in mechanical novelties.

MEASUREMENTS OF RESISTANCE.

OSCAR N. DAME.

Measurements of resistance are made by comparing the unknown resistance to be measured with certain standards of known resistance, there being several different methods in general use. The standard resistance coils are made of German silver or platinum alloy, as these metals have high resistance, which varies less than other metals, with change of temperature. Resistance boxes are constructed with a large number of coils of varying resistances, so that by means of plugs about any desired resistance can be obtained.

One of the most commonly used methods is that of



THE WHEATSTONE BRIDGE.

X = unknown Resistance.

a and b are fixed resistances in proportion to one another; for instance, as 1 to 100 or 1 to 1,000.

R= an adjustable resistance which should be adjusted until there is no galvanometer deflection with both keys depressed.

Then this ratio exists:

$$A : b :: R : x \text{ or } ax = bR,$$

that is, the products of opposite sides of the bridge are always equal to each other.

Should a and b be equal, then x=R.

Should a : b = 1 : 100, then x = 100 times R.

Often further accuracy is required. For example: Let a=10 and b =1,000; x = between 5.11 and 5.12

Notice the galvanometer deflection to left and right and less resistances in "R" and calculate by proportion the excess of the true resistance over the lesser.

R=5.11=for instance, 6 deflection to left=d_1.

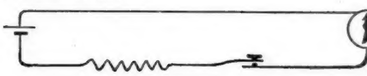
R=5.12= for instance, 12 deflection to right=d_2.

Then $(d_1+d_2) : 1 :: d_1 : y$

that is $(6+12) : 1 :: 6 : y$

that is $(18 : 1 :: 6 : y =$ about .3

hence x = 5.113.



SUBSTITUTION METHOD.

We know from Ohms law that with the increase of resistance in a circuit, there is a decrease of current. This gives a simple method of approximately determining resistance, but it is not as accurate as the preceding method.

The battery of known E. M. E., the unknown resistance and a galvanometer are connected in series; the current passing will be indicated by the latter. The unknown resistance is then replaced with known resistance until the deflection of the needle is the same as with the unknown resistance.

Galvanometer resistance=say 100.

Battery resistance = say 0.

X=unknown resistance and R=known resistance.

A resistance of 320 w=deflection of 20 divisions or points.

An unknown resistance gave 30 points.

$x=\frac{d_1}{d}(R + G)—G$, or by arithmetic, $x = \frac{20}{30}(320 + 100) — 100=180$ ohms.

that is, X= known points divided by unknown points multiplied by the sum of the (known resistance and resistance of galvanometer) and then the resistance of the galvanometer subtracted from that.

$x=\frac{d_1}{d}(R + G) —G$, *i. e.* x = unknown points.

EASY ELECTRICAL EXPERIMENTS.

ARTHUR H. BELL.

The possessor of an induction coil giving an inch spark or over, may construct, at small expense, a number of interesting accessories with which to amuse himself and friends.

The first device, Fig. 1, is constructed of wire and a pivot turned or drilled and filed out of brass rod. Because of the direction given to the wire and points, the electric discharge at the gap causes the device to revolve in a remarkable manner, as long as the coil is in operation.

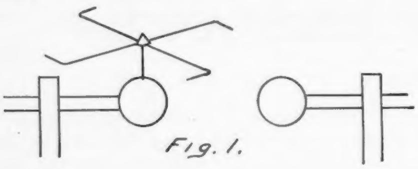


FIG. 1.

Another device, which is simply made and can be developed into a fascinating display for store windows or other exhibition purposes, is the tempest display, illustrated in Fig. 2. The houses, church, flag pole and trees may be designed in any shape desired, but must be whittled out of soft wood and painted in natural colors. All of these houses rest permanently on a metal plate, which may be covered with sand to more closely resemble the earth. All of the objects, whether houses or trees, must have the uppermost portions connected with the metal base by a fine concealed iron or copper wire, which plays a very important part in the successful operation of the device. Above the houses and trees is suspended, by fine wires, a sheet of metal screening, such as fly screening. This screen is connected to the positive terminal of a spark coil and the metal plate to the other terminal. When the coil is set in operation, sparks play about the trees and church spires just as they often do in summer tempests. Though described in crude form, this scheme is worthy of development, and bright amateurs possessing coils will readily perceive the ways of perfecting a regular landscape, with sky, storm clouds and artificial downpour. The writer built such a device a few years ago, and had the pleasure of seeing it in constant use for several weeks in a prominent store window, and realizing therefrom a considerable revenue for the rental of what every one declared to be the successful window display of the year.

It is also possible to construct an attractive display by using pith, taken from corn or cane stocks. Pith is an article of commerce and may be readily purchased of apparatus dealers, and often of druggists. Little balls of pith when inserted loosely between plates such as were described for Fig. 2, will jump and bob about in an animated manner, and if puppets of pith are constructed to resemble persons, dogs and other animal life, their remarkable antics will cause much speculation and amusement for the uninitiated.

The writer once purchased quite a large ball of pith and decorated it with colored inks. This ball was fastened to a stout straw and counterbalanced by a shoe button at the other end. The see-saw-like affair was suspended from the upper plate, half way down, by a fine silk fiber, and as the fittings of the device, including the sheets of metal were all painted a dull black, it was impossible for any outsider to tell the cause of the wonderful see-saw motion.

Another simple device is to write a name on a strip of black cardboard and punch out the lines with a stout needle or awl. This card is placed close to and in front of the spark gap of the Rhumkorff coil, and in the dark the illumination of the letter is very fascinating.

The writer also remembers a mouse trap altered to cause instant death to the mouse, when the trigger was released. Most readers are accustomed to the round red mouse traps which have five or more holes into which the hungry creature thrusts his head, only to be gripped by a noose of iron wire actuated by quite a powerful spring. One of these mouse traps was placed on a metal plate, and the trigger and spring so arranged for a wipe contact that when the cheese bait was moved inside the primary of the induction coil was set in operation and a current of high voltage sped through the mouse's body, bringing instant death. The secondary of the coil was connected to the metal plate and to another little plate just inside the hole, not actually in direct contact with plate number one. There are many other simple ways that a small coil can be utilized, and of these the writer may treat in succeeding numbers, with the hope that his amateur friends will try all the experiments and endeavor to devise new and original ones.

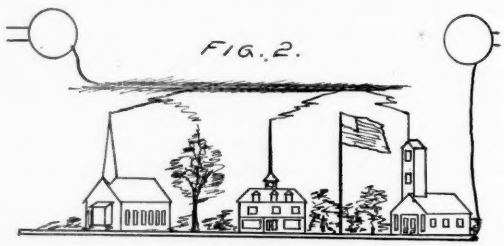


FIG. 2.

POINTERS ON THE USE OF DRILLS.

The removal of the stub of a stud or bolt broken off short in the hole, leaving nothing to get hold of, is not such a hopeles job as it looks. Put a center-punch mark or "center-pop" exactly in the center of the broken bolt and drill a hole clear through it with a drill 1/8 to 1/4 in. smaller in diameter than the bolt, according to the size of the bolt, and drill straight, leaving a thin shell of the broken stud. The heat and vibration of the drilling frequently has the effect of loosening the stud, which is, of course, an advantage n the final operation. Then take a piece of square steel measuring diagonally, from corner to corner, one-sixteenth inch larger than the driled hole. Taper it slightly so that the small end will just enter the hole, taking care that the corners are straight and sharp. Drive it lightly into the shell of the broken stud, just enough to make it grip, and with a wrench unscrew the shell. If it is found that the steel drift revolves without turning the stud, drive it a trifle harder; but remember that if driven too hard it will simply expand the shell and make it more difficult to remove.

A good way to loosen a stud that promises to be difficult to start is heat to a bright red a piece of iron that will just enter the hole drilled and leave it there until it cools to almost black. Then, with a squirt-can or in any other convenient way, apply cold water to the shell and immediately drive in your drift and apply the wrench. The purpose is to loosen up the rust by the alternate and unequal expansion and contraction of the stud and surrounding metal.

If all such efforts to dislonge the stump prove ineffectual, there is a last resort which seldom fails, but which should not be attempted except in case of necessity. With a narrow cape chisel or triangular file, cut a groove the full length of the hole drilled in the stub, cutting the groove just to the bottom of the thread. This will cut the shell so that the cape chisel, applied at the top near the groove, will close it into the hole, loosening it so that it will easily come out.

To place a hole with extreme accuracy, make the center-pop with a sharp-pointed punch, called a "prick-punch," and describe a circle with your dividers just a trifle larger in diameter than the hole is to be. If the hole is to be small a plainly marked circle will be sufficient, but if the hole is over 1/4 in. make four center-pops with the prick-punch exactly on the circle at approximately equal distances apart. Start the drill, and before it has cut in far enough to bury the beveled part, stop drilling, and examine the work. If the edge of the started hole is exactly concentric with the circle, or equi-distant from each of the center-pops made on the circle, the hole is started true. If, however, the preliminary cut is off center, make a center-pop in the hole a trifle further from the exact center of the drill point than the distance by which the hole is out of true. Make the center-pop quite deep, so that the point of the drill will be drawn out of its original course enough to true the hole. Drill a trifle deeper and examine the cut, if necessary, repeating the operation. A little preliminary experimenting will make this quite clear. The process is called "drawing" a hole. When large drills are used, say from 5/8 in. up, instead of making a center-pop, a groove is cut down the side of the cut with a round-nosed chisel, as a center-pop would not be sufficient to draw so large a drill.

When drilling steel or wrought iron, the drill should be kept well oiled or it will soon overheat and lose its temper and, besides, will cut less freely. Cast iron and brass, however, must be drilled dry, and for the latter the speed of the drill should be as high as possible for small holes.

Grind twist and fluted drills so that the cutting edge is left projecting a little. If this is not done the drill will simply glide around on a beveled end, taking at most only a very slight scrape instead of a full cut. If a drill seems sharp but refuses to cut it will generally be found that the troubie is lack of "backing off," as it is called. When grinding be careful to keep the point exactly in the center of the drill, for any little variation in its position will cause the hole drilled to be larger than the diameter of the drill. In fact, it is a common practice, where a hole of slightly larger size than the drill is wanted, to grind the tool a little off of center. This is a makeshift, of course, and is to be recommended only when there is no other way out of the difficulty.

A drill for enlarging a hole already drilled should have a small flat ground on the lip just behind the cutting edge. For ordinary drilling this would reduce the depth of cut and make the drill work very slowly and heat up quickly; but in enlarging a hole the drill has not the steadying influence of the point to guide it, and, as ordinarily ground would, as soon as it touched the metal, dig in viciously and stick. If the driving power were greater than the resisting force, something would, of course, give way, and the something is likely to be the drill. Fluted drills are better adapted to enlarging holes than twist drills, the latter having more tendency to draw in than the former. Never trust to a drill for enlarging if you want the hole to be smooth and true, for the drill, having no support from the center, will "wabble" and make the hole irregular. A little caliper work on any enlarged hole will show this very readily. If there is no reamer at hand to ream a hole to the desired size, the hole ean be plugged, the plug center-popped and a new hole of the correct diameter drilled through the plug.

To drill a hole in any metal that is too hard to be touched by a drill of ordinary hardness, try hardening

in mercury or strong brine. Drilling very hard metal with a glasslike tool is, however, a very unsatisfactory business, and should be avoided, if possible. The proper hardening of tools is an important matter, and though long experience is necessary for the production of the best results, ordinary tempering may be done by the amateur with a little practice. Take a flat drill, for instance. Heat the drill to a bright red for about half an inch from the point and dip it vertically into the water, point first, completely submerging it. Do this quickly and then bring it up so that only the cutting edge and a little more of the drill remain in water, and hold it there for a few seconds. Take it out of the water, and, as quickly as possible, polish off one side of the point, brush your finger quickly over it and watch the colors appear on the clean place. If you want the drill very hard, wait until the cutting edge assumes a light straw color, and plunge it entirely under water, holding it there until it is comparatively cool. A dark blue color will give a cutting edge too soft for ordinary work, and between these two colors can be found any desired temper. This method will leave the shank of the drill soft, so that it will not snap under strain, as it would if it were made as hard as the edge. Another way to bring the drill to the correct temper is to harden it outright at once, and reheat until the proper colors appear; but this is not usually as satisfactory as the first method, which is the one generally used in shop practice. The point is hardened outright and the shank left soft and so hot that it transmits enough heat to the point to reduce the hardness to the proper degree. If the shank is too hot the colors will flash along the point so quickly that the proper one cannot be caught and the line between the hard and the soft part is apt to be too sharply defined. If too cold, there is not heat enough to do the work, and the drill will have to be re-heated to temper it.

COMMERCIAL SUCCESS.

It has been remarked, and with truth, that one of the secrets, perhaps it may be termed the chief secret, of commercial success is enthusiasm, wisely directed, of course. The business man who strives to invest his duties, day by day, with the spirit of enthusiasm, may be said to give his day's task a good "set off," as it were, while he is likely to get through his work with less expenditure of nerve force, and with a greater degree of pleasure to himself than if he started in an indifferent or dull frame of mind, as many business men are, unfortunately, so often accustomed to do.

The foregoing observations may truthfully be said to apply to every branch of business, including that of engineering. This is a "point" which the young engineer should take careful note of. He should remember that our great engineers and inventors did not achieve distinction merely by dogged application to the task on hand, but likewise by the enthusiastic way in which they, as a rule, went about their respective work.

Some of our eminent living engineers, electricians and inventors (whose names might easily be adduced), are noted for the jubilant spirit with which they invariably invest their labors. They appear to find a perennial pleasure in their work; and that is exactly what everyone, the academically-trained professional, commercial men, and artisans alike, ought ever to strive to do. They will thereby be able to find pleasure—nay, even delight—in the performance of their work, whatever it may be. We are quite well aware of the fact (and it is an ugly fact, too) that many men are today pursuing a calling for which they have no particular liking. Such unhappy souls are frequently heard to say "that they do not care for the work, but it is the only kind of business that they are qualiffed for." Such individuals, and we fear they are somewhat numerous, are assuredly to be pitied.

It is a pity for any man to have to follow a trade or profession which does not lie near to his heart. He is not likely to attain distinction, nor even ordinary success in his own sphere of labor. There would be fewer of this type of worker in our midst at this present hour if parents studied the "bent" of their children's minds ere apprenticing them to a trade. The natural taste of a child should always be allowed due weight when determining upon their future life calling. Indeed, we do not know but that it should rank as a primary element in the matter, that is, assuming that the youth or girl is physically and mentally qualified to pursue the particular line of business towards which his or her native bent of mind points.—*Engineering and Iron Trades Advertiser, Glasgow.*

The inspector-general of the Paris, Lyons & Medditeranean Railroad Company, Lyons, France, says that his road uses large quantities of coal briquettes, about 10 per cent of its fuel consisting of them. Thus the road is enabled to utilize all the slack and coal dust from the mines. The engineers can get up steam more quickly with briquettes than with any other kind of coal without them. They form no slag or clinkers and tend to prevent the formation of clinkers when used with other coal. The company manufactures its own briquettes. About 95 per cent of its fuel consists of fine coal or slack. Coal briquetes are in very general use in France, hardly a household being without them during cold weather. They are more easily handled and more readily ignited, and they throw out more heat than coal and make no dirt at all. They are preferred to any kind of coal.

If a man empties his purse into his head, no man can take take it away from him. An investment in knowledge always pays the best interest.—*Franklin.*

SCIENCE AND INDUSTRY.

U. S. Consul Halstead, Birmingham, England, re reports: The Nonex is a device which, according to public tests recently made in London, renders all receptacles containing inflammable liquids comparatively secure from explosion. The device is an application of the Davy lamp, supplemented by a fusible cap or plug.

If a vessel of ordinary type, containing an explosive liquid, be subjected to sufficient outside heat, or if the contents be lighted at the orifice, the walls of the tank will burst by the force of the expansion. At an exhibition given by the owners of the patent, a 20-gallon tank was partly filled with gasoline and placed upon a lighted bonfire. The fusible screw cap, made in two parts which were simply soldered together, soon blew out, the solder having melted, and the ascending vapor caught fire immediately; but no explosion followed because the orifice of the tank formed the upper end of a tube which projected down inside the vessel to its bottom, where it was closed. To allow the oil or gas to percolate from the interior of the tank each of the metal layers of which this tube was composed had been perforated, and, while the perforations would permit the spirit to be poured out, they prevented the passage of the burning gas to the interior by absorbing its heat as the wire gauze does in the Davy lamp. While the gasoline contained in the tube burned the flame did not extend to the liquid or accumulated vapor in the half-full tank and, consequently, there was not sufficient expansive force generated to burst the tank. The flame was easily extinguished with a bundle of rags and then lighted and put out several times. The gasoline would, I judge, percolate constantly through the perforated layers of metal to the inside of the tube and there keep up a continuous burning; but according to the accounts of tests which I have read, the flame does not appear to have been allowed to burn any length of time to see how long the metal layers of the tube could absorb the heat without becoming so hot that they would heat and dangerously expand the gasoline in the tank. A motor car tank to which the device was affixed, was lighted with a match and extinguished at will. A gasoline can without the device exploded almost instantaneously when lighted.

The device applied to small gasoline cans, kerosene drums and other petroleum containers, would undoubtedly serve a desirable purpose.

U. S. Consul Hamm, Hull, England, reports: The need of a standard screw in the more delicate branches of engineering has long been acknowledged by the profession. This lack has been especially evident in optics and gunnery; but the difficulties in the way of obtaining such a standard have been just as evident. The British war office seems to have overcome most if not all these difficulties, and to have succeeded in constructing one which it is claimed will stand every test. Recognizing the importance of having a standard screw in gun fittings and mountings, the war office was led four years ago to appoint a committee of experts to investigate the subject and devise means for the production of the article wanted. The result of the labors of this committee can now be seen in the new standard screw-cutting lathe just set up at the National Physical Laboratory at Bushy House, London.

It became clear at an early stage of the investigation that to secure interchangeability in screws it was necessary to supply accurate standard leading screws from which the screws could be cut and to construct a special lathe on which these leading screws could be adjusted and measured. The standard screw now in Bushy House is made of compressed steel and is some 6 ft. in length. The lathe to which it is attached exceeds 20 ft. in length, and as it works to so fine a degree of accuracy as to correct an error of one ten-thousandth part of an inch, every precaution has been taken to protect it from the vagaries of temperature by housing it in a special building heated to a constant temperature of 60°. The lathe differs in construction very greatly from ordinary lathes. The leading screw and the screw to be cut are coaxial. No gear wheels are employed, and there are means for automatically correcting even the most trifling errors of the leading screw.

A British trade journal states that the Elektricitats-Aktien-Gesellschaft, of Frankfort, has recently introduced a convenient machine for testing the lubricating qualities of oils. The essential part is a short shaft working in a bearing and loaded appropriately. About half a pint of the oil under examination is poured onto the bearing, and the shaft is set revolving at a definite speed. The time that elapses before the shaft comes to rest is noted; the greater the time the better is the lubricating quality of the oil. After the test the bearing is cleaned by pouring over it a liquid in which the oil is soluble and then removing the liquid by a blast of air; this method of cleaning is found to be quite effective and is economical of time. The machine may be driven by an electric motor or other mechanical means or by hand, and there is an arrangement of resistance coils by which the bearing can be heated up to any required temperature. Both the bearing pressure and the speed may be conveniently arranged.

One characteristic feature of Australian hard wood trees, of which there exists an almost endless variety, says *Carpenter and Builder*, is the great size of the beams which may be obtained from them, as well as the extreme toughness and durability of their wood, the gray ironbark having a resistance to breaking equal to 17,900 pounds per square inch, as compared with a mean of 11,800 pounds for English oak and 15,500 for teak. None of the other timbers has so high a resistance to breaking as this description of ironbark, but nearly all the varieties have a greater strength than oak. The quality of the wood is materially in-

fluenced by the soil on which the trees grow, while the absence of branches for the greater portion of the height, enables the timber to be obtained to the best advantage; and as full grown trees of most varieties are rarely less than 100 feet high, with corresponding girth, the quantity of timber obtainable from the virgin forests is very great.

German papers state that pure and clear water can contain disease germs for a long time in a living and poisonous state. It has been presumed that disease-causing bacteria could not increase in pure water, and therefore, soon died, due to the effect of light, low temperature, current of the water, other harmless germs, and lack of suitable nutrition. It has been demonstrated that the typhus baccillus requires at least 67 milligrams of nitrogenous matter in one quart of water, and the sewer germ over 400 milligrams. The typhus baccillus is said to be able to live only seven days in common waterworks water, and the cholera baccillus only three days. It would appear that these researches were made somewhat superficially, as, according to Mr. Konradi, water is suited to many disease germs which in time overcome harmless bacteria instead of succumbing to them. The experiments of Konradi with the baccillus Milzbrand, which causes inflamation of the spleen, and the typhus baccillus, have demonstrated that the harmless bacteria in the water increased largely for some time, but died subsequently, so that, finally, the water kept in ordinary room temperatures contained only the disease bacteria in full malignancy. The "spleen" bacillus remained alive from 264 to 816 days, and displaced the other bacteria within three to four weeks. The pus baccillus overcame the other baccilli after three months and lived 508 days, while the typhus baccillus become dominant only after more than fonr months, but lived 499 days. The "spleen" baccilli thrive even in sterilized water.

According to M. P. S. Guedras, in *Comptes Rendus*, a new method of blasting has been tried. Calcium carbide is introduced into a metallic cartridge, separated by a diaphragm from the necessary water for its decomposition; the cartridge also contains an air space and a cavity having a detonater. The cartridge is introduced into a bore-hole, which is tamped with a wooden plug, and by striking a projecting-rod the diaphragm is pierced. After five minutes the cartridge is exploded by firing the detonater. The rock is shattered, but not projected, and can be easily hewn with a pick. The charge of carbide is fifty grammes.

The forests of the United States have become so reduced that they can last but a few decades at most. Those of the South will be gone by 1925, and of the Pacific before 1950. The seaports of the South Atlantic and Gulf of Mexico are exporting rapidly to South Africa and to many European marts, besides supplying ties and timbers for a large portion of this country in which the wood has become exhausted.

There are no forests being propagated throughout the South. Annual fires, a vicious practice to give fresh grazing for a few animals, keeps the young pine from growing, while baby saplings are having their life-blood drawn for the turpentine stills.

With the general indifference of the public there is no hope for a future timber growth of value. Where trees remain they are of inferior quality, and undergrowths, where they exist, are of little prospective importance.

New England has not enough timber for her own factories; eight inch trees are being sawed into box lumber. The four Middle States are dependent upon the South, having no timber left. The prairies remain treeless, except as a few groves are being planted, insufficient to be seriously considered. Four States may furnish lumber for a little while: Oregon, Washington, Northern California and Idaho.

With calls for timber from Asia, Africa, much of Europe and all of the United States, what prospect is there for a permanent contribution to all these fields without a greater effort to protect the young growth and to economize in that of mature age?—*Arboriculture.*

In a recent article in the *American Machinist*, W. Osborne calls attention to one source of difficulty in starting a gas engine which is worth noting. When the engine stops without turning the fuel off, the cylinder will be left full of gas, and unless this gas is worked out by turning the engine over several times, there will be little air mixed with the fuel when an attempt is made to start the engine and ignition cannot take place. Letting the engine stand with the exhaust valve open or working it back and forth to drive the gas from the cylinder allows easy starting.

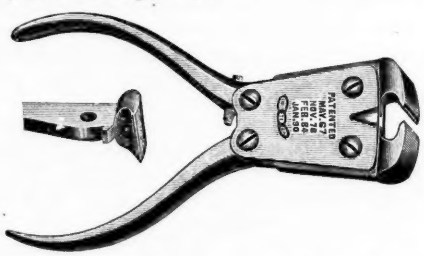
Experiments have been made recently at the Allston shops of the New York Central Railroad, with an electrical horseshoe magnet attached to a set of locomotive driving wheels to determine the degree of magnetic resistance it was possible to exert. It was found that with the attachment employed the adhesion was increased fully 35 per cent. The Central will have 30 of its locomotives fitted with the device, so as to do away with the use of sand.

Several experiments have recently been made at Camogli, near Genoa, Italy, with a new submarine boat. The craft is intended to recover objects from the bed of the sea, and for this purpose is provided with powerful hooked arms worked by electricity. So far the greatest depth reached is 58 fathoms, and at this the men were able to breathe and work freely.

Ether and chloroform, so useful in sending men to sleep, have the very opposite effect on plants, which are stimulated to the greatest possible activity by these drugs. In Denmark and Germany, advantage has been taken of this fact to force flowers in rooms and glass houses and to make them bloom out of season. The results are said to be marvelous.

TRADE NOTES.

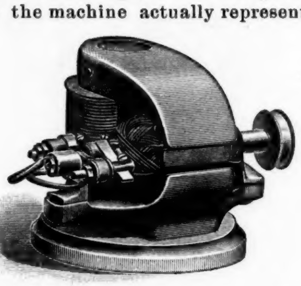
The need of an improved compound nipper with parts perfectly interchangeable has long been felt. Hall's compound and cutting nipper, manufactured by the Utica Drop Forge & Tool Co., Utica, N. Y., has been remodelled and the parts are in every respect interchangeable. The advantage of such a tool is that it lasts indefinitely; when a part becomes worn it can be replaced at a slight cost.



The nipper is simplicity itself and will not get out of order; the parts are so constructed that with the aid of a screw-driver a new part can be inserted quickly and easily. Its construction throughout is of the best quality of tool steel, carefully hardened and tempered; the jaws and handles are drop forgings and not castings. All parts are guaranteed.

The extreme leverage makes it the easiest cutting nipper on the market. It can be had in three different finishes; black with polished jaws and plates, full polished or nickel plated, in the following six sizes: 4, 5, 6, 7, 8 and 11 in. If specially ordered it can be furnished for cutting music wire. New York office, No. 296 Broadway.

This well-known machine has been on the market since 1894, and the manufacturers, The Elbridge Electrical Mfg. Co. of Elbridge, N. Y., take great pride in the fact that the machine actually represents the fin-



est possible construction throughout, and that its present first-class design and high efficiency are not the result of guess work or imitation, but rather brought about through more than ten years of gradual development and improvement, step by step.

"The Midget" is one of the smallest dynamos on the market, but unlike many others, it has almost every detail of large commercial machines and is, therefore, suitable for teaching and experimental purposes; in fact, the machine with hand power, is to be found in many of the schools and colleges in the world. Every facility has been provided by the manufacturers for the production of these machines at the smallest possibie cost, consequently they are able to offer a better quality of goods at lower prices than would be possible without their facilities.

Weight of the Midget without hand power, 4 pounds; weight with hand power, 12 pounds; height of hand power, 11 in.; length of outfit with hand power, 20 in. Pulley $\frac{7}{8}$ in. diameter for 3-16 in. round belt.

The Midget has a short magnetic circuit with wrought iron magnet core and pole pieces accurately bored so that the armature clearance is only 1-32 in. Brass bearings are held in place by a single screw in each, and shoulders are provided for end chase. Brush holders are strong and easily adjusted, field coil is shunt wound in even layers throughout; it has heavy fibre bands. The armature is a perfect model in every way, has a lathe turned shaft, laminated core with perforations for the winding and waterproof insulation. The commutator is of copper, of good size and is well insulated.

The makers rate the Midget as having an output of 10 watts, that is, the load the machine will carry continuously, but it is able to deliver, for short periods, as much as 40 or even 60 watts. Every machine is also tested to operate as a motor, and made to run without load on a total expenditure of $\frac{1}{4}$ of a watt of electrical energy.

With each machine is sent a little booklet of instructions for the care of machine, and for conducting 35 of the most important electrical experiments, including experiments in magnetism, gold, silver, nickel and copper plating, exploding powder, electric, lighting, etc.

The machine can be furnished with or without power, and is often supplied for special purposes to order. The Elbridge Company will be glad to correspond with all interested parties. No charge is made for experimental work necessary to perfectly adapt the Midget to special requirements.

The new catalogue recently issued by Carlisle & Finch, 228 E. Clifton Ave., Cincinnati, Ohio, decribes a number of new things which are of interest to readers of this magazine. A gasoline engine of 1-6 h. p. 2-cycle type, is of simple construction and just the thing for running small dynamos for charging storage batteries, or model lighting plants. It is of solid construction for the size and will undoubtedly give excellent service.

A 500-watt dynamo, or $\frac{1}{2}$ h. h. motor of excellent dedesign, a 150-watt alternating dynamo, a 150-watt multipolar dynamos, igniting dynamo of several types, water-motor and several new model railway outfits are other equally interesting things, making the catalogue one which every amateur interested in mechanics should possess.

Upon the advent of the automobile no wheel was found adapted to it. The wire wheel was tried and it did not look right; then the wood wheel was tried and it did not work right. The one is not adapted to a carriage; the other is not intended for an engine. A wheel that would meet both of these requirements was needed; one that would look like a wood wheel and work like a steel one. The wheel of an automobile has to do something more than carry weight; it must transmit the power of the motor.

In a horse drawn vehicle it is evident that there is no twist or torque on the hub of the wheel, for the power is applied through an axle that does not turn; the wheel is revolved by the friction of the road, and the only resistance to this motion is the frictional reresistance of the bearing, which in the case of a good one is very slight.

The wheel of an automobile must transmit the whole power of the motor which is applied to it (usually) at the hub. This work it must do in addition to carrying the weight of the car and taking the sidewise thrusting strains whenever a car departs from a straight line. It must do all that an ordinary carriage wheel does, as well as all that the motor may call upon it to do, and no wheel is more illy adapted to take this torque or hub strain than one with a metal hub and a wooden spoke, nor is there any better abapted to such service than one that is made all in one piece.

A wood wheel depends upon the rim to hold it together. If the wood shrinks the rim must be shortened in order to bind the parts together; this can be done in the case of a carriage wheel but it is impossible in an automobile, because the size of the rim is fixed, and any alteration in it will destroy its usefulness as a seat for the tire.

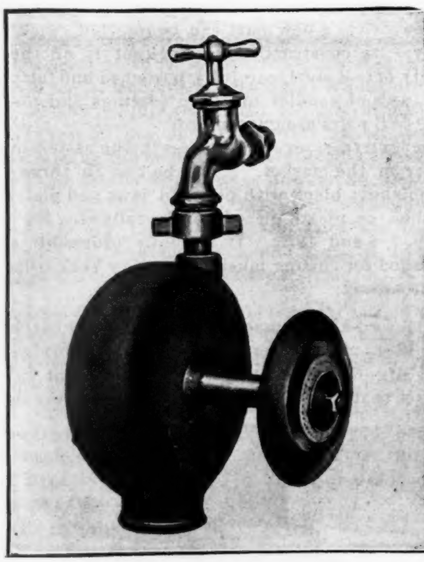
This has made the wooden automobile wheel unreliable and short lived when the climatic conditions are unfavorable, for it is impossible to season wood so that it will not be affected by the varying conditions of climate.

The Midgley Pressed Steel wheel, as illustrated above, and manufactured by The Midgley Manufacturing Co. of Columbus, Ohio, is made wholly of sheet steel: nothing else enters its construction, and it will be found to fully meet the requirements of the most exacting service.

We herein illustrate a new and very useful article offered by the Smith & Hemenway Company of 296 Broadway, publishers of the "Green Book" of hardware specialties.

It is a water motor which actually develops ⅛ brake horse power on 80 pounds pressure from a city main, using a No. 50 nozzle, or about ⅛ in. stream; 80 pounds being the ordinary pressure from a city main. Motors are furnished this way unless specially ordered.

The little motor develops a speed on pressure mentioned above of 4500 r. p. m. with an ordinary 5 in. emery wheel or a 9 in. buffiing wheel for polishing. The emery wheel is suitable for grinding knives, scissors, razors, axes, hatchets, hammers, or in fact, any edged tool. The buffing wheel is suitable for polishing, cleaning and buffing any metal surface.



This will be found a valuable addition to any boarding house, restaurant, dentist, butcher or private house where any grinding is to be done. It also has sufficient power for running sewing machines, small lathes, scroll saws, dynamos, etc.

The illustration above shows the motor attached to an ordinary screw sink faucet in a private residence and can be adjusted to either the right or the left hand side.

The total weight complete, put up in a box, with polishing wheel or buffing wheel, emery wheel, stick polish, is 6½ pounds. Printed matter and prices will be sent upon application.